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JULY, 1957

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EDITORIAL

AS we go to press, we note that the Postmaster General has called for tenders to construct a co-axial transmission line between Sydney and Melbourne via Canberra.

Extra traffic channels between our capital cities are becoming more and more essential as the pressure upon them grows, and the only useful method of expansion is via wide band co-axial cables or micro-wave radio links.

Until such links are available, we will have no prospect of exchanging T.V. programs throughout the Commonwealth. It is quite impracticable to send T.V. signals over telephone lines for such long distances.

Considerable diversion of opinion exists between engineers as to whether radio links are better than co-axial lines. Radio links are fine for jumping over mountainous country, for instance, where co-axial cables would be almost impossible to lay down. They are generally spaced about 40 miles apart, whereas cables need repeater points about every nine miles.

There are too many pertinent factors to make any easy estimate or comparison.

It may well be that the most practical link would be a combination of both cable and radio.

But it seems certain that a single link will be only a starting point, for such huge capital cost must be integrated with communication services as a whole. Experience overseas has shown that more channels can be needed for T.V. services than for communications, for the same channel which will transmit a single T.V. program will handle about 600 telephone circuits.

When T.V. really gets going in this country, there will probably be pretty constant use for at least one channel on T.V., and we cannot visualise a situation in which so many telephone circuits are put out of action.

Whether the P.M.G. decides to use cables, radio links or both, the main thing is that an early start is planned.

It is unfortunate that in such a large country our centres of population and commercial activity are so widely dispersed, for it makes such projects extremely costly to install and to use, but our scattered State makes the need for good communications all the more pressing.

It will not be long before T.V. is established as a very special means of communication, and we must include interstate links among those things which are part and parcel of the T.V. system. Let's hope that these new facilities can be pushed along with the greatest speed.

John Moyle

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RADIO ★★ TELEVISION AND HOBBIES

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OUR COVER PICTURE

HOW'S THIS FOR A CAMERA? — One of the latest Hasselblad cameras fitted with a telephoto lens recently on show at Olympia in London. It takes 35 mill. pictures, has interchangeable lenses and costs about £800.

Palec

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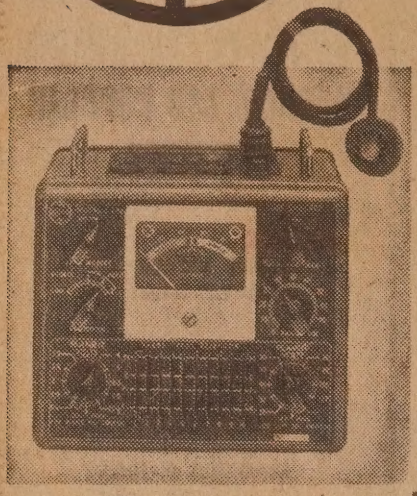

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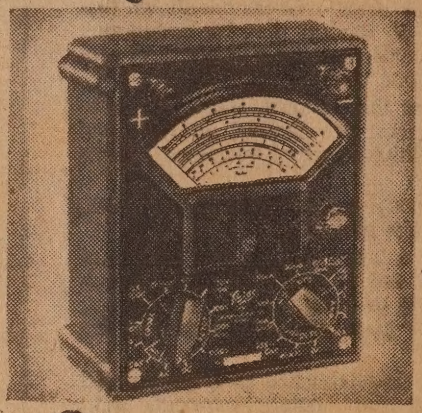

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MX32	Multimeter (20,000 Ohms/Volt)	£25 17 6
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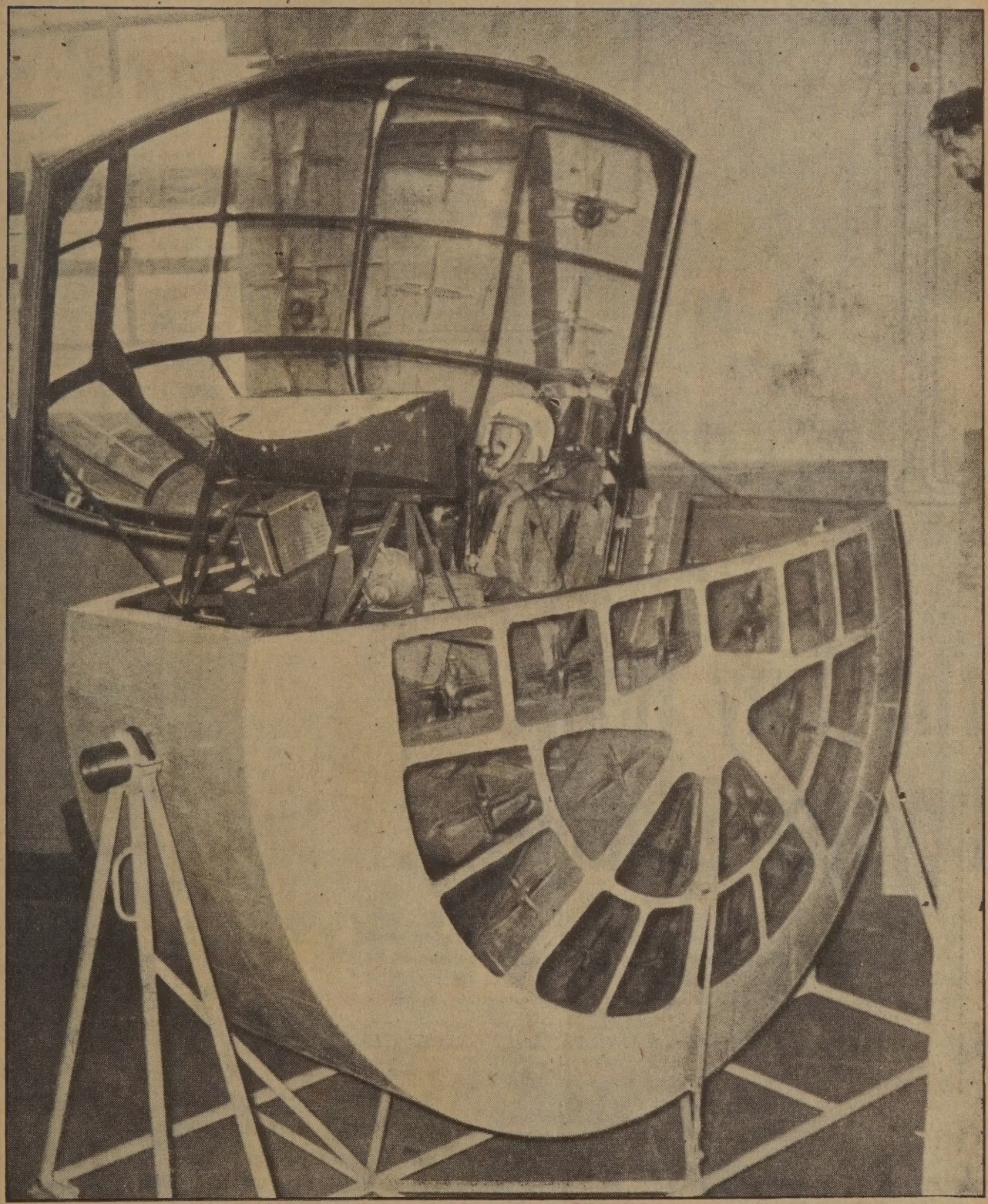
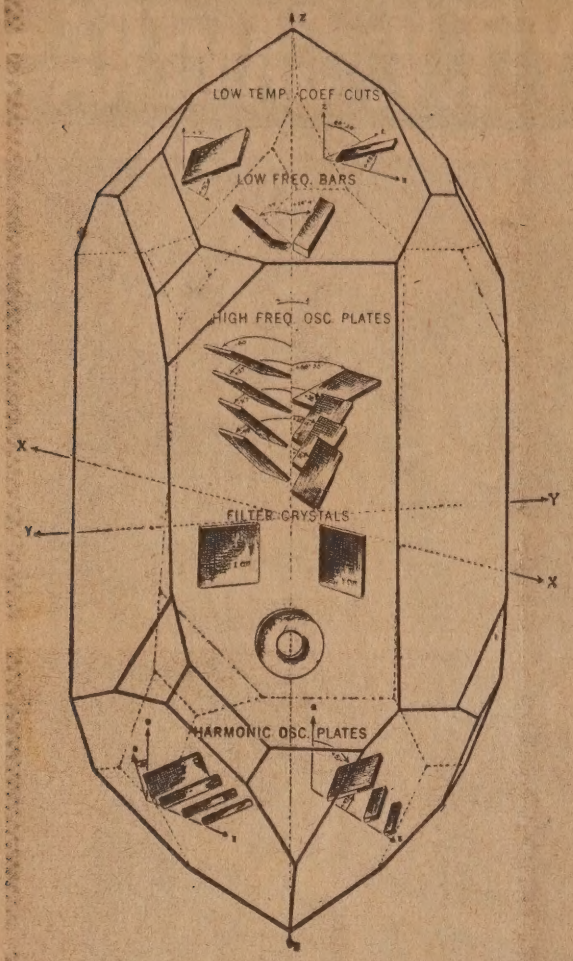
FLIGHT TESTING BY T.V. CAMERA



TO TEST FRENCH AIRMEN this centrifuge has been installed in the Medico-Physiological section of the Bretigny flight test centre. It is used for measuring the physical resistance of the pilot to acceleration, and the development of protective clothing. The pilot, shown seated, is whirled around at speed as the device is rotated on its central shaft. A T.V. camera registers his reactions.



Left: This diagram shows the orientation of oscillator and filter crystals with respect to the ones of the "mother" or natural crystal. Each cut has its own particular use.

1: The correct sawing angle of the crystal as determined by x-ray analysis, is assured by orientating the specimen on this machine.

2: The next step is to place the glass mounted crystal under a diamond-edged saw. The saw table is fitted to slice the quartz along the desired plane.

3: Wafers are diced into segments by a smaller diamond edged wheel.

4: Here are the prepared blanks ready for grinding to their desired thickness.

5: The crystal blanks (here circular in shape) are ground or "lapped" to thickness in this device. The top grinding plate, seen hanging on the peg and coated with grinding powder, is rotated over the bottom plate holding the blanks.

6: This precision guage will check accuracy of lapping to one ten-thousandth of an inch. Finally, the frequency of the crystal is compared with known standards over a wide temperature range.

The Tiny Heart of Crystal Stability

The discovery of the piezo-electric effects of quartz crystals revolutionised the frequency stability of transmitting equipment. Recent developments of the ultra high frequency bands for communication have been made possible by the remarkable accuracy in control achieved by these tiny wafers of quartz. This picture story tells you how crystals are made.

MILLIONS of people operate their radio receivers and find each station precisely on its assigned frequency. The twist of a selector switch on a television set brings in the desired picture on its correct high-frequency channel. A fogbound ship at sea obtains its bearings accurately from distant shore stations. An airliner makes a perfect landing in zero-zero weather. Police cars converge on an escaping criminal. A businessman speeding along a highway reports to his home office by radio. Scattered groups of armed forces keep in constant touch with their commanding officer. Photographs are transmitted to distant points by radio signals. Much of the world's business is conducted through this modern phenomenon of radio communication, which fills the radio frequency spectrum with a multiplicity of signals.

CRYSTAL CONTROL

How is it possible, then, to avoid a Babel of meaningless dots and dashes and unintelligible voices? The answer is twofold. First, government and international regulations assign to each class of communication specific portions of the frequency spectrum, like a certain group of keys on a piano.

Second, each transmitting station is kept precisely on its particular frequency by a remarkable little device called a "Crystal Unit."

The heart of this unit is a small quartz plate, fashioned with precision from a single crystal of silicon dioxide. In its raw form, this material looks much like a hexagonal prism of glass, with somewhat irregular, tapering sides that terminate in a pyramidal apex at each end.

Natural quartz crystals are found in many parts of the earth, but the largest and best specimens come from mountains of Brazil. The age of these crystals and the conditions under which they grew are subjects of much speculation. Although found thousands of feet above sea level, it is believed they were formed thousands and perhaps millions of years ago, when that part of the earth was submerged deep in the bed of the ocean.

PIEZO-ELECTRICITY

Whatever their true history, it has been discovered that these crystals possess a remarkable property.

When mechanically compressed along certain directions, electrical charges are formed and, conversely, when electrical voltages are applied, mechanical distortion of the crystal takes place.

This piezo-electric property is found in many other crystals, but none has so many desirable features. Hardness, durability and economy of procurement make quartz outstanding for stabilised control of radio frequencies.

RESONANT FREQUENCY

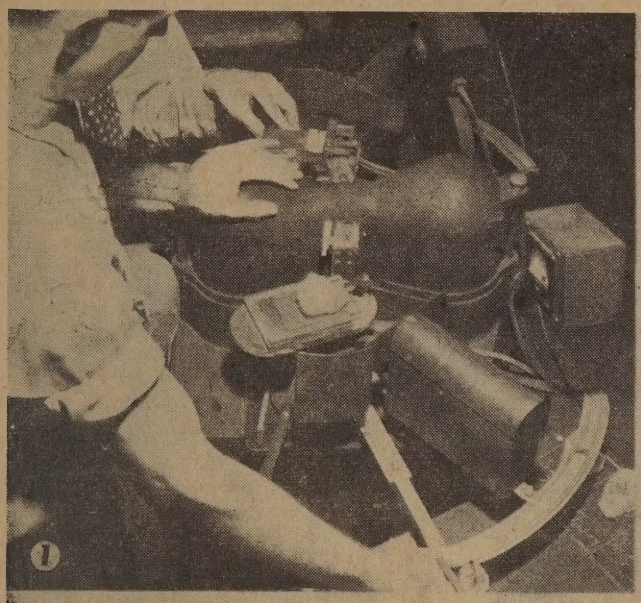
How can small pieces of rock be used to control radio frequencies?

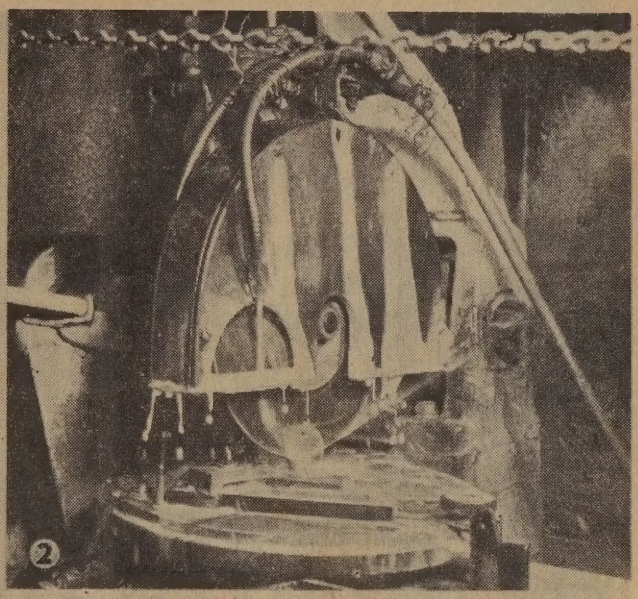
The answer rests in another unique property of quartz crystals. When the raw material is cut into thin wafers in certain directions by means of diamond saws, and rectangular or circular plates are fashioned from these wafers, each has the property of offering high resistance to all but certain critical frequencies.

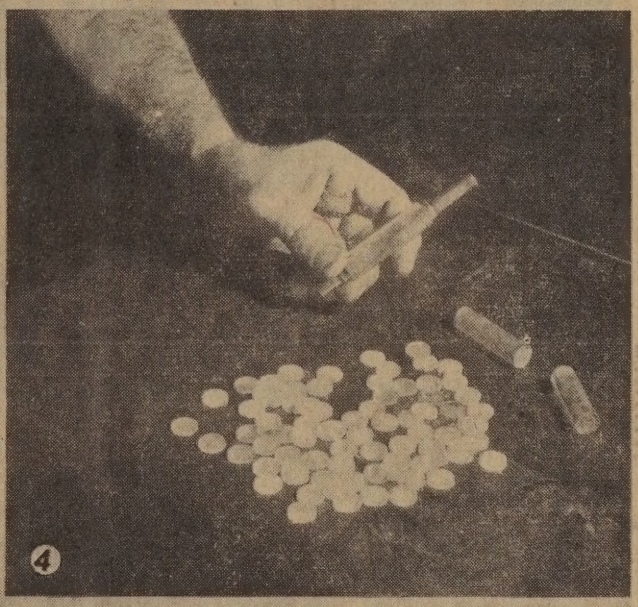
These are determined by both the orientation of the wafer from the mother quartz and the final dimensions of the crystal. Critical frequencies or resonant points may be shifted to any desired value by slight changes in boundary dimensions.

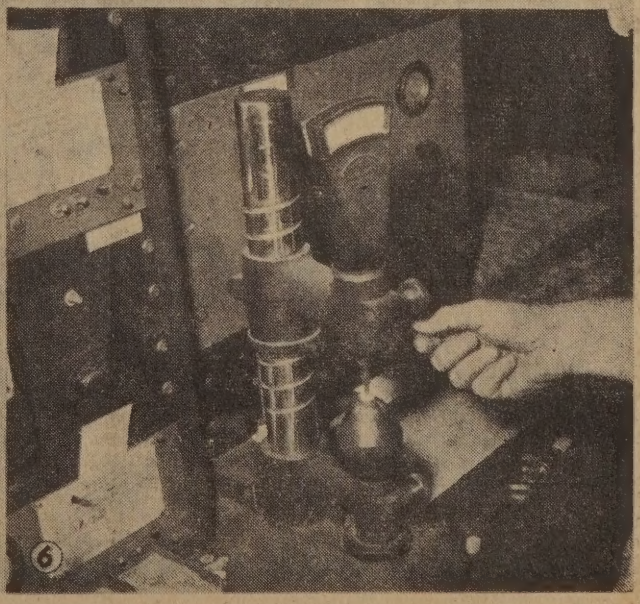
At each such resonant point the resistance or impedance of the quartz plate drops to a low value. This behaviour, combined with the piezo-electric property, permits an electronic circuit to function normally. The only frequency at which the circuit can be employed is the exact resonant frequency of the crystal, or at one of its harmonics.

METHODS OF CUTTING AND GRINDING CRYSTALS









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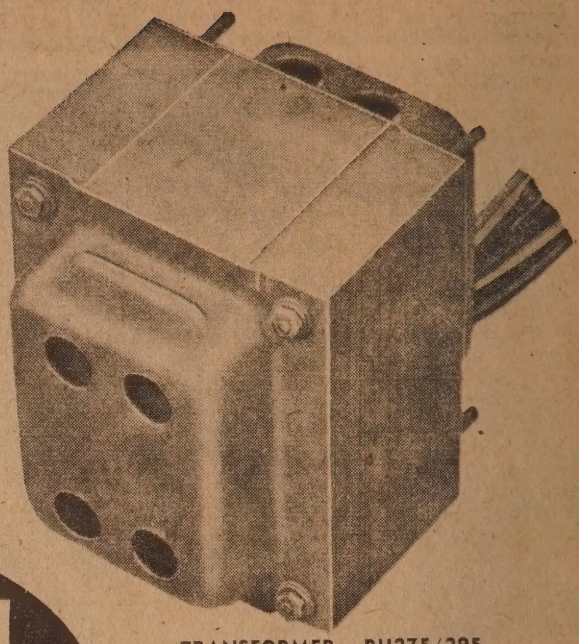

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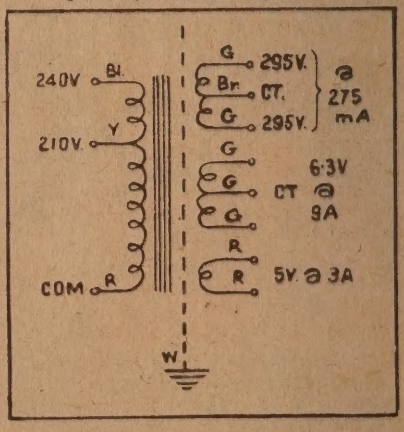

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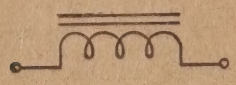

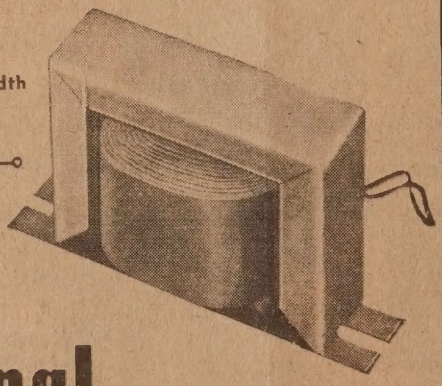

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Order is established in the radio spectrum by a high degree of frequency stability, and in a large majority of cases this is obtained by using crystal control of all transmitters.

Since this was made possible more than 20 years ago, what is the justification for continued research?

The usable radio spectrum is, at the present, limited to frequencies extending to a few thousand megacycles, with the vast majority of all radio communication taking place at much lower frequencies. The important consideration is that **there exists a practical limitation to the width of the usable radio frequency spectrum,** and already the demand for channel allocations is so great that there is not enough room for all unless the width of each channel can be reduced.

The actual width required for each channel of communication depends upon two things, first the type of transmission employed and, second, the degree of frequency stability which can be maintained.

Even though crystal-controlled, the frequency may drift slightly from its assigned value.

Temperature changes, vibration and aging cause the properties of the crystal to change slightly, with a corresponding variation in resonant frequency.

FREQUENCY DRIFT

It is quite common practice to avoid drifting effects owing to temperature variations by enclosing the crystal in a constant-temperature oven. There are many applications, however, where the weight, size or power requirements of ovens cannot be tolerated.

The only remaining possibility is to fashion the crystal so that its tendency to drift is greatly reduced. Here is a problem for the research engineer.

Our engineers have determined to a high degree of precision the exact angles of orientation at which the finished quartz plates must be fabricated for lowest frequency drift. X-ray measurements of atomic planes within the quartz are used to an accuracy of less than one minute of arc. The optimum orientation is not a constant angle for all frequencies, but must be varied according to orientation curves, depending upon frequency and crystal boundary dimensions.

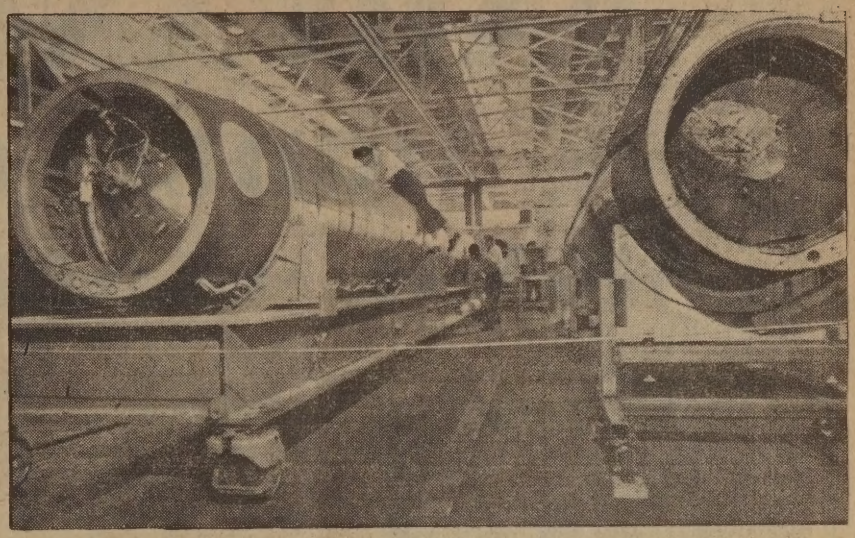
AGING EFFECTS

Developing crystal fabrication techniques that will decrease frequency drift caused by aging is a second problem confronting the research engineer. This is far more serious than suspected.

Aging effects can cause gradual frequency deviations far outside permissible limits, and this in a short time. By recognising the existence of damaged crystal surfaces, engineers took a large step towards minimising the causes for this behaviour. Abrasives employed in lapping produced faults, which are now eliminated by dissolution in a potent chemical such as hydro-fluoric acid.

After the etching operation, it was also found beneficial to submit all crystals to a high-temperature baking cycle, such as an annealing process, to remove any final traces of strained areas within the quartz plate. These practices,

WILL CARRY EARTH SATELLITE



First picture of the giant, 3-stage Vanguard rockets designed to carry the first earth satellites into space, taken at the Martin Co. plant in Baltimore, U.S.A.

which we have employed for the past 10 years, are now generally recognised as effective anti-aging treatment.

Although usable radio frequencies extend to thousands of megacycles per second, the major portion of crystal-controlled frequencies lies below 200 megacycles.

Crystals with natural resonant frequencies of this value are not as yet commercially available, and unless employed in circuits specially designed to excite them at overtone or harmonic modes, the top practical frequency limit for crystals is about 16 megacycles.

OVERTONE CIRCUITS

To arrive at the desired carrier frequencies between 16 and 200 megacycles it has been necessary to use frequency multiplier stages or special "overtone" circuits. The early method was to use a series of frequency doubling or tripling stages in the transmitter design. This system is still employed in many high-power, fixed stations; but where space and weight are at a premium, it is far more desirable to have the oscillator circuit itself operating at the carrier frequency or as near that as may be feasible.

Fifteen years ago engineers discovered that a **specially fabricated quartz plate could be operated at three times its fundamental frequency.** This had the effect of reducing the number of frequency multiplier stages required.

Later developments showed that similar "overtone" crystals could be used reliably when operating at higher orders of odd harmonics, such as the fifth, seventh, ninth, etc. There are but few practical uses of these units above the third overtone, but here research shows that the fifth, seventh and ninth modes may also be employed with dependability.

This development is extending crystal oscillators to higher and higher frequencies. Five years ago the top frequency for a crystal of the overtone type was about 20 megacycles; to-day, that limit has been advanced to 50 megacycles. **The top limit, however, has not been reached.**

A factor contributing to reduction in size is the deposition of the two metal electrodes directly to the major faces of the quartz plate in the form of thin metallic films. The fabrication of plated crystals was pioneered during World War II, when millions of plated, high-frequency crystal units were supplied for the armed services. The original electrode material of **evaporated aluminium was changed to silver** for better electrical contact. **Present research is advocating the use of gold,** because of improved stability characteristics.

SMALLER AND LIGHTER

Whatever the material employed, the weight per unit is far less than former designs which used thick, separate, metal electrodes. A modern, hermetically sealed crystal with plated electrodes weighs but one-ninth of an ounce, as compared to a prewar unit of the same frequency, weighing almost five ounces. Equally startling is to note that a pre-war crystal occupied a space of more than 2½ cubic inches, whereas its modern equivalent requires less than two-tenths of one cubic inch.

Crystal engineering research still goes on. Primary objectives are to expand the frequency range of both fundamental and overtone crystals, to improve constructional features and to increase heat dissipation properties. This will expand the usable frequency spectrum, give greater stability, and enable larger amounts of power to be handled. Circuits are being developed for measuring performance characteristics and to further minimise aging effects. These efforts to attain greater precision and frequency stability help conserve frequency spectrum space by reducing channel widths.

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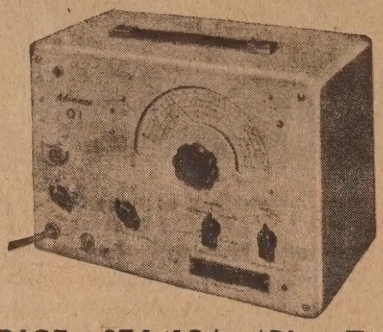

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A fast airliner from Britain touches down and the passengers, with the air of London barely out of their lungs, come down the gangway. Then, unobtrusively, an official extracts from the wing-tip of the aircraft a small container. Here's another express consignment of atoms, the export of which is becoming an important part of British nuclear activity.

By NIGEL CALDER

EVERY week, from its laboratories at Harwell, England, and its radio-chemical centre at Amersham, England, the United Kingdom Atomic Energy Authority despatches more than 200 samples of "radioactive isotopes" to countries overseas. They are atoms of familiar chemical elements like carbon, phosphorus, iodine and gold, but they are "hot"—giving off atomic rays during a process of radioactive decay.

VARIETY OF USES

Many radioactive materials lose their radioactivity rapidly — sodium for example loses half its strength in 15 hours—and because they decay in a few days and give out dangerous amounts of radiation this "half-life" as it is called is so short, consignments have to go by air. Because of the weight of protective containers this was an expensive undertaking, making medical use costly until Dr. E. C. Halliday, of Pretoria, hit on the idea of carrying them in the wing-tips. This is now a normal facility in British aircraft.

Ordinary atoms can be made into radioactive isotopes by "cooking" them in a nuclear reactor; some are to be found in the spent fuel-rods of the reactor—the fragments of split uranium atoms. By whatever means they are created, they have an astonishing variety of uses.

The medical applications are well known. Radioactive cobalt, Co-60, makes a cheap substitute for radium in treating deep-seated cancer and its powerful gamma rays destroy the cancer as surely as a surgeon's knife. For other cancers and tumours, there is radioactive gold, Au-198. And many hospitals receive radioactive iodine I131 for the diagnosis and treatment of thyroid trouble.

Atomic rays can penetrate deep into foodstuffs and interrupt the normal living processes which make them deteriorate. Raw beef will keep about three or four times longer in a refrigerator if it is first treated with atomic rays.

Harmful parasites in pork and poisonous bacteria in eggs can be destroyed in the same way. But the taste of food may be affected, so there are still difficulties preventing the immediate adoption of the techniques.

MAKING THINGS GO

Almost every industry has jobs where "hot" atoms can help to make things go more slickly. Let me give a few examples out of hundreds.

Perhaps you are a water engineer and you want to find a leak in an underground pipe. If you just introduce a harmless amount of radioactivity nito the water you can follow its progress from above the ground with a Geiger counter.

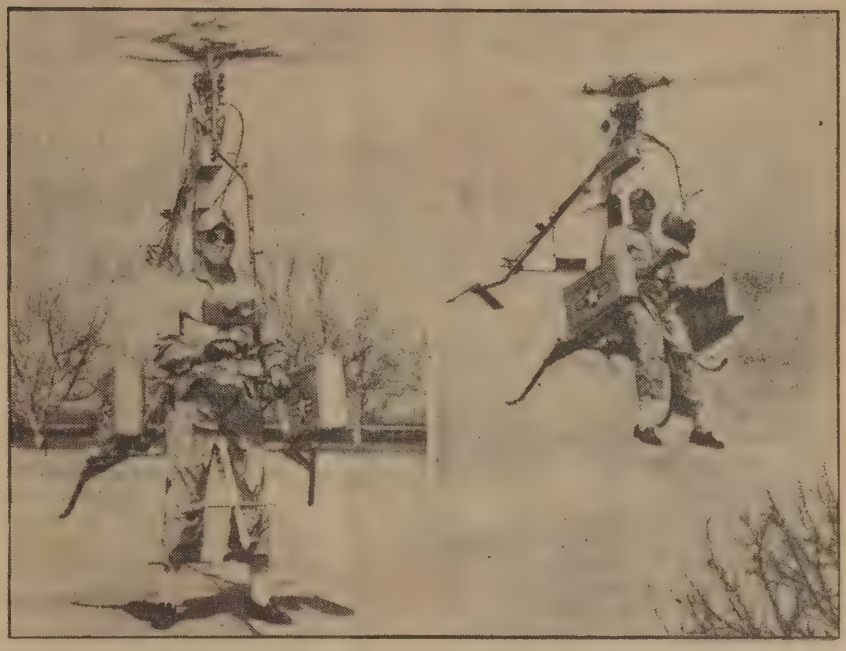
If you make petrol engines it would be useful for you to know how quickly a piston becomes worn in various circumstances. You can send the piston to Harwell and get them to cook it in a reactor so that the metal becomes radioactive. Then you can put it in the engine and detect the minutest amount of wear by testing the oil for radioactivity.

You will almost certainly want to check your castings by radiography to make sure there are no hidden flaws; you could use a cumbersome and expensive x-ray machine, but it is much easier just to put a speck of radioactive caesium, Cs-137, on one side of the casting and a photographic plate on the other.

But this is just the beginning of the radio-isotope story. It is little more than 10 years since "hot" atoms came on the market. Already, chemists have found that they can use atomic rays in making new plastics and synthetic rubbers, and for vulcanising natural rubber.

And scientists investigating the chemical processes of life can introduce radioactive "tracers" into a living organism: the "hot" atoms go through the same chemical antics as their stable counterparts, but they give themselves away by their radio-activity. One of the mysteries investigated in this way is the chemical effect of sunlight on plants.

NEW STRAP-ON-BACK HELICOPTER



Pilot Dick Whitehead goes aloft in a new, one-man, strap-on-the-back helicopter known as the "Pin Wheel" and built by Roto-Craft of Glendale, California. Powered by rockets, it is designed to fly an infantryman and his equipment about a battle-field regardless of obstructions or terrain. Its manufacturers hope to sell it to the U.S. Army.

TINY ATOMIC BATTERY POWERS WRIST WATCH

PROMETHIUM a radioactive fission product of nuclear reactors and an element non-existent in nature, finds one of its first uses in a novel atomic battery. The tiny battery was developed by an American company for use in a wrist watch. Similar batteries are expected to be used to power portable radio receivers, hearing aids, equipment in guided missiles, &c.

First the battery yields light, which it then turns into electricity. Beta rays from Promethium 147 oxide make cadmium sulphide, a light-emitting phosphor, glow. Silicon photocells transform the light into 20 microwatts of power in the present model but larger and more powerful models are expected to be developed.

A shielding alloy 1-16in. thick confines the mild radioactivity and amply safeguards the wearer of the watch.

The new battery is said to be immune to heat, cold and self-damage by radiation. Short-circuiting it does no harm and power drawn from it does not do it any harm. Lasting as long as its Promethium 147 (estimated half life about 2½ years), it retains one-fourth of its original power for five years, which is considered its useful life.

The promethium it uses, now costly, will become plentiful and inexpensive with quantity production.

PUBLIC SERVICE

OF

Papua and New Guinea

VACANCIES

DEPARTMENT OF POSTS AND TELEGRAPHS

Supervising Technician (Radio) Grade III

£1562-£1592 p.a.

Qualifications: P.M.G. Senior Technician (Radio) or equivalent; extensive VHF and HF experience.

Duties: Install and maintain regional radio communication equipment; inspect stations; supervise technical staff.

Senior Technician (Radio)

(5 positions)

£1232-£1292 p.a.

Qualifications: Pass in P.M.G. Senior Technician (Radio) examination or equivalent.

Duties: In charge zone transmitting and receiving stations (transmitters 500 W power); MF/HF, CW and radio-telephone trunk and out-station services.

Technician (Radio)

(5 positions)

£1062-£1172 p.a.

Qualifications: Pass in P.M.G. Technician (Radio) examination or equivalent; HF and VHF experience desirable.

Duties: Assist in maintenance and operation zone and out-station radio equipment.

Supervising Technician (Telecommunications) Grade II

£1442-£1472 p.a.

Qualifications: P.M.G. Senior Technician (Telecommunications) or equivalent; automatic and manual telephone experience essential; supervisory ability.

Duties: Install and maintain exchange equipment in district; supervise staff.

GENERAL INFORMATION

SALARY: *Rates quoted are actual for unmarried appointees and include allowances and adjustments. Additional Territorial allowance is paid as follows:—*

	Unmarried £	*Married* £
Less than 5 years' service	—	125
5 years' service but less than 7	25	150
7 years' service and over	50	175

ELIGIBILITY: *Adult male British subjects under 45 years.*

APPOINTMENT: *Permanent subject to satisfactory probationary period.*

LOCATION: *Appointees are required to serve anywhere in the Territory.*

ACCOMMODATION: *Single quarters only available. Married accommodation not available under 18 months from date of appointment.*

SEPARATION ALLOWANCE: *Payable at discretion of Territory Administration; designed to compensate for added expense of married appointees obliged to maintain family outside Territory.*

LEAVE: *Three months after each 21 months in Territory. Additional 3 months' leave after each 6 years' service and 6 months' furlough after 20 years' service.*

TAXATION: *Income derived by residents of Territory from sources within Territory is not at present taxable under Commonwealth legislation.*

FURTHER INFORMATION: *An information Handbook on the Public Service of the Territory is available from the Department of Territories, Canberra or Sydney, or from any Commonwealth Public Service Inspector, District Employment Office or official country Post Office. Other enquiries to Department of Territories, Canberra ('Phone U 0411, Ext. 28A).*

APPLICATIONS: SUBMIT *on prescribed form available from offices mentioned under "Further Information".*

TO *The Secretary, Department of Territories, Canberra, by 6th July, 1957.*

Senior Technician (Telecommunications)

£1232-£1292 p.a.

Qualifications: Pass P.M.G. Senior Technician (Telecommunications) examination or equivalent; automatic and manual telephone experience.

Duties: Install and maintain equipment at main exchange.

Technician (Telecommunications)

(6 positions)

£1062-£1172 p.a.

Qualifications: Pass P.M.G. Technician (Telecommunications) examination or equivalent; automatic and manual telephone experience.

Duties: Install and maintain equipment.

Senior Radio Telegraphist

£1232-£1292 p.a.

Qualifications: First Class Certificate of Proficiency (P.M.G.) or equivalent; ability transmit and receive at 25 w.p.m. and touch type 30 w.p.m.; two years' commercial experience desirable.

Line Foreman Grade I

£1112-£1142 p.a.

Qualifications: P.M.G. Line Foreman or equivalent; cable, conduit and aerial experience; leadership qualities.

Duties: Supervision staff in field; maintenance plant and equipment.

TOV43.94.57

HIGH-SPEED COMPUTER NO BIGGER THAN A T.V.

A high-speed digital computer, not much larger than a home television set and requiring less power to operate, has been developed at Bell Telephone Laboratories. This newest addition to the family of electronic "brains" was developed under Air Force contract. It has been named "Leprechaun," after the tricky sprite of Irish folklore.

Leprechaun is a new, high speed digital computer distinguished by its low power and size. It can be used as a research instrument for digital computers specially designed for military applications. Free use of transistors keeps power consumption small.

COMPARED with previous computers, Leprechaun operates with a drastically reduced number of components. Excluding its magnetic cores, it uses only about 9,000 electrical components. More than half of these are transistors.

Some 5,000 of them are used in Leprechaun. The use of transistors made possible the small size and low power requirements of the computer.

HIGHLY FLEXIBLE

Leprechaun represents a significant advance in computer design. One of its outstanding features is its flexibility. Its components can be easily connected and disconnected. This allows the computer to be used as a test model for research on digital computers designed for military applications. Proposed new designs can be laboratory-tested through the use of Leprechaun without resorting to construction of new equipment.

Another feature of the new computer is its transistor-driven "random-access magnetic core memory." The machine can take its instructions immediately from its memory, no matter where the desired instruction may be stored. This process differs from that of computers with a "revolving drum memory" which may require time for the rotation of the drum before the instruction can be taken from its place.

Almost instantaneous solutions to the problems it has to solve are provided by Leprechaun since any of its stored instructions are immediately available. Each instruction consists of the operation to be performed, such as addition, multiplication, etc., and the location of the data in the memory.

DOESN'T FORGET

The machine can store 1,024 "words" in its memory. These words consist of 18 binary or dual digits, representing instructions or data to be used in solving problems. In computers, all information is translated into a special code which uses only combinations of 0 and 1. These binary digits can be represented in Leprechaun by the flow or absence of electricity in the transistors, by the direction of magnetisation in the memory cores, or by holes in punched paper tape.

One reason for building Leprechaun was to demonstrate the feasibility of "direct coupled transistor logic." This is a switching circuit technique in which transistors are used to perform logic or "brain" operations as well as to provide power.

Compared with previous computers, the circuits of Leprechaun are very simple and easily understood. This is an advantage in engineering and maintenance, since less experienced personnel are required to keep it in operating condition. Leprechaun's simplicity and small number of components result in small size and weight and will permit the use of automation techniques in manufacturing. All these features ensure greater reliability, which is of primary importance in military operations.

While Leprechaun is still in the experimental stage, the techniques developed are expected to have many future applications.

X-RAY MICROSCOPE NEW TOOL FOR RESEARCH

A POWERFUL new tool for research into hitherto unexplored fields of metals, foods, chemicals and criminology is a new x-ray microscope recently produced in America.

While not as powerful in its magnifying power as the electron microscope, the x-ray microscope has an advantage in that it does not require mounting the specimen in a vacuum and other special preparation techniques.

Under development for more than four years, the x-ray microscope promises to reveal hidden facts concerning such vital facts as corrosion in metals, the effect of foreign materials in metals, the soundness of electroplated coatings, and the effects of various processes on the behaviour and structure of metals.

Secret of the x-ray microscope lies in the extremely tiny size of the focal spot, which is bombarded by electrons and thus caused to give off x-rays. This target is only 40-millionths of an inch in diameter. X-rays emanating from such a small spot fan out in all directions and hence magnify any object which they pass through. The x-ray microscope achieves magnifications up to 1,500 times, and at the same time discloses the inner structure of the object being examined.

Basically, this is how the x-ray microscope works: A narrow beam of electrons emerges from an electron "gun". This beam is cut down to desired size by a condenser lens, and then passes through an objective lens. The tiny beam then bombards the target made of a sheet of tungsten which is thick enough to stop the electrons but thin enough to permit the generated x-rays to pass through. The remainder of the instrument is a simple shadow projection microscope.

FOREMOST IN SOUND

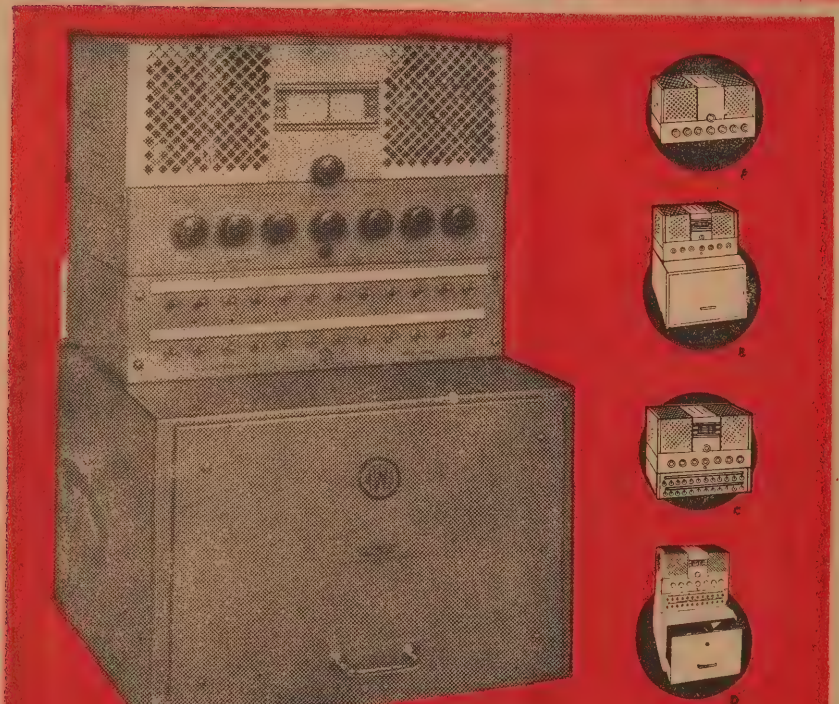
ADDRESS, RADIO AND RECORD PLAYING SYSTEMS

PAGING

INSTRUCTING

ENTERTAINING

COMMUNICATION



There is a planned A.W.A. Sound Reproduction system for every need in the commercial, industrial, educational, cultural and entertainment activities in the community.

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ALSO FROM LEADING WHOLESALERS

TRANSISTOR PRODUCTION LINE

Big strides are being made in the transistor field. These pictures come to us from Delco Radio Division of General Motors, which has just produced a high-power transistor car radio set using no valves or vibrators. The method of making transistors described here is now fairly standard.

GERMANIUM, the heart of the transistor, must be fantastically pure to operate properly.

Manufacturing processses purify the germanium until there are approximately one billion germanium atoms to only one impurity.

But then it is too pure — for transistor action requires minute amounts of a known type of impurity.

The impurity in this case is antimony —one part to 10 million parts of germanium.

In the purifying process used at Delco Radio, a graphite "boat" of germanium requires some eight hours to move through the special zone refining device. This zone refiner has a series of eight induction heating coils in its some 12ft length which heat the germanium to its melting point eight times during the process.

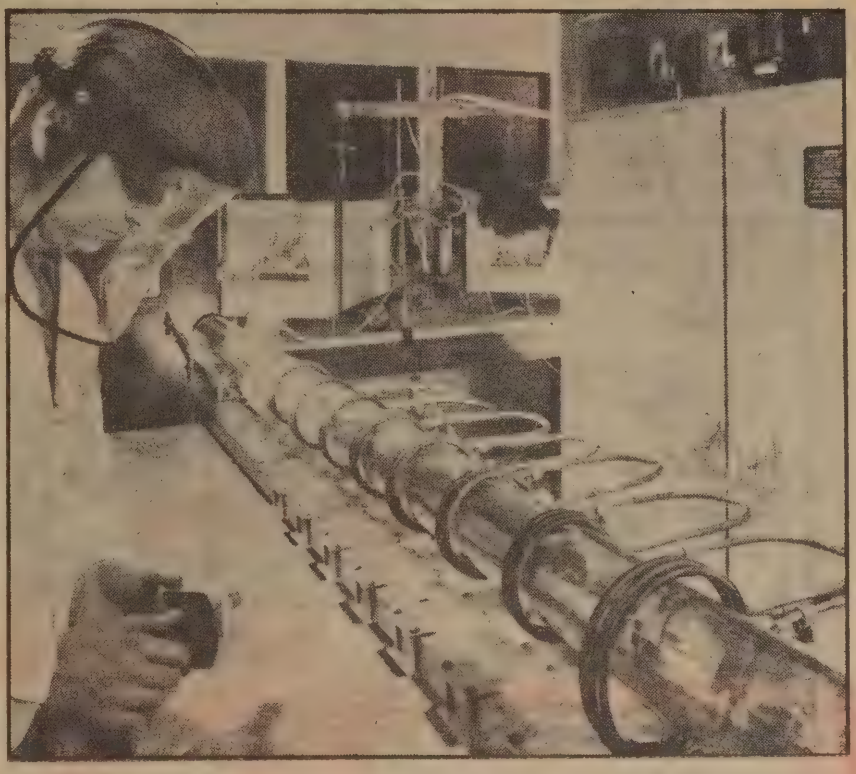
In between each coil the germanium cools, sweeping the impurities to the ends of the boat. Thus, each of the eight coils contributes to the purification of the germanium.

GROWING PROCESS

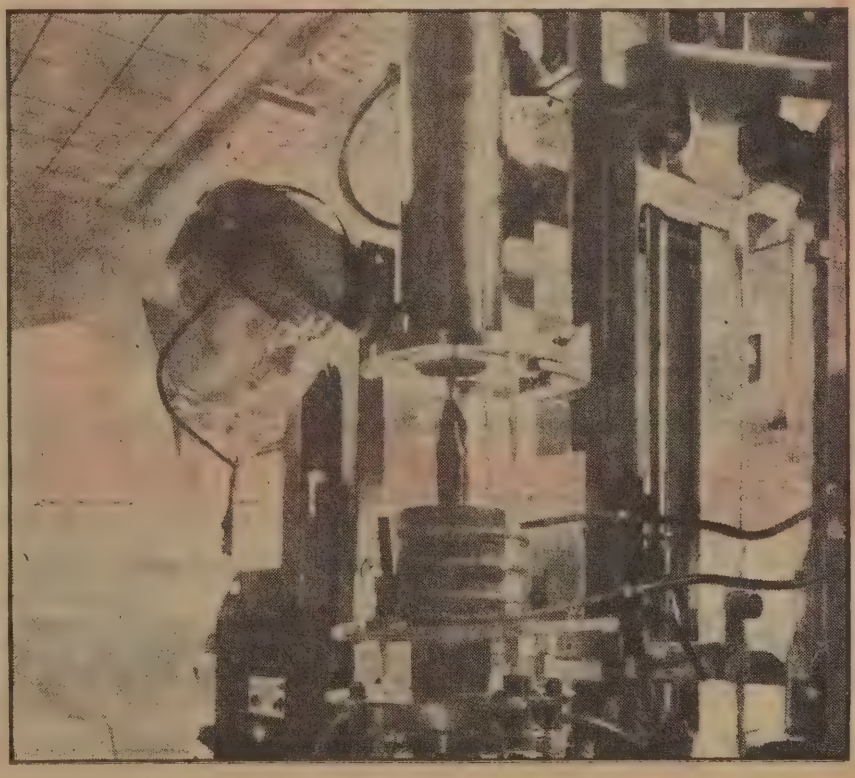
Once the germanium is purified, it then is ready for the "doping" and the "growing" processes. In these processes the infinitesimal amount of antimony is added and the germanium atoms are arranged to provide avenues for the carrier of current, electrons and "holes".

To do this, a "seed" of germanium in which atoms are perfectly arranged in lattice-like structure is dipped into the molten germanium mixture. The seed is rotated slowly and imperceptibly withdrawn from this mixture. As it is withdrawn, molten germanium clings to it and solidifies, growing a stick of germanium some 11 inches long and about an inch and a half in diameter which is accomplished in approximately five hours.

This single crystal stick is sawed by diamond saws into thin slices. These slices are then ground to an accurate



This photograph shows a large induction heating coil around a quartz housing down which a graphite "boat" of germanium moves in some eight hours. Each coil heats the area beneath it to above 947 degrees Centigrade, the melting point of germanium. In between the coils the germanium cools, sweeping the impurities to the ends of the boat as crystallisation takes place. Thus each coil contributes to the process.



A physicist studies the growth of a large germanium crystal which can be seen in the centre of the quartz housing. In some five hours, the crystal will be about 11 inches long and half an inch thick, worth more than £1,500.. It will be cut into wafers three-tenths of an inch square and less than one hundredth of an inch thick.

ELECTRONIC A&R EQUIPMENT

TV NEWS

Available Now! A New A&R Transformer Kit for the R.T. & H. Television Receiver!

Mains Transformer

For the R. T. & H. 17" T.V. Receiver

MAINS TRANSFORMER: DESIGN P.T. 1840
Primary: 200, 230, 240V.
Secondary. 290-CT-290 V @ 275 mA
Filament: 6.3V @ 9 Amps. 5V @ 3A
Horizontal mounting this transformer is designed for low radiation, and in addition is fitted with a copper flux shorting shield to further reduce the external magnetic field. Colour- coded leads Height above chassis 3½in. Base size 4½in x 3⅜in. Mounting centres 3⅜in x 3in Cut out 3 1/8 in x 2 3/8in Weight 11¾lb.

Filter Choke

DESIGN Z 1091. Inductance 1 Hy. @ 275mA, D.C. D.C. Resistance 30 ohms A strap clamp mounting with leads. Designed for low voltage drop (Approximately 8 Volts at maximum current). Base size 4in x 2in Mounting centres 3 9/16in Height above chassis 2 9/16in Weight 2lb.

T.V. Kit

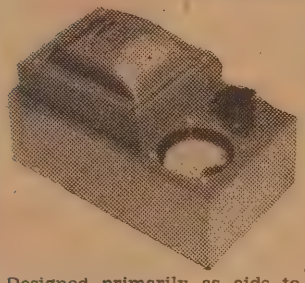
(Designed for use in T.V. circuit published by Philips Elect. Ind. Pty. Ltd.)

POWER TRANSFORMER: DESIGN P.T. 1790.
Primary: 200, 230, 240V 50 cps.
Secondary 230-CT-230V @ 350 mA.
Filaments: 2 x 6.3V @ 6 A.
Horizontal mounting. Fitted with copper flux shorting shield. Colour-coded, flexible leads. Height above chassis. 3½in. Base size 4¾in x 3⅜in. Mounting centres 3⅜in x 3 1/16in.

FRAME OUTPUT TRANSFORMER: DESIGN O.T. 2507
Designed to Philips' specifications. A strap clamp mounting, with colour-coded leads. Height above chassis 2 9/16in. Mounting centres 3 3/8in Base area 3⅜in x 2 3/16in.

POWER CHOKE: DESIGN Z 1090.
Inductance: 3 Hys @ 300 mA. D.C. Resistance—50 ohms. An open clamp mounting (reversible) with leads

T.V. Voltage Adjusters



AVAILABLE IN BOTH AUTO WOUND AND DOUBLE WOUND MODELS WITH OR WITHOUT 0-250 v METER FITTED.

Designed primarily as aids to servicemen in installing and servicing television receivers, these Voltage adjuster units are now being used in other applications such as correction of input voltages to Amateur transmitting and receiving gear, tape recorders, Hi-Fi audio equipment, etc., where the load imposed is within the capacity of the adjusters.

AUTO MODEL TYPE: A.T. 1215 (illustrated)

Input voltage (50 cycle A.C.): 190, 195, 200, 205, 210, 220, 230 or 240, adjustable by means of tapping switch. Input connector: Bakelite 3-wire type enabling any convenient length of mains cord to be used. Output voltage: 200 to 240 as selected internally. Output power: 300 V.A. (maximum output current 1.3 A.) Output voltage indicator: 0-250V A.C. Meter (Optional). Output socket: standard 3-pin flush type. Weight including meter: 7½lb.

DOUBLE WOUND MODEL TYPE: P.T. 1832

Input voltage: as for Auto model. Input connector: as for Auto model. Output voltage: 200, 230, 240 as selected internally. Output power: 200 V.A. (Maximum output current 0.8 A.) Output voltage indicator: as for Auto model. Output socket: standard 3-pin flush type. Weight including meter: 11lb.

FREE! Reference Folders, Pamphlets

Specification sheet and price list No. 2 has just been released. This handy reference folder gives full details of electrical specifications, physical dimensions (illustrated for easy reference) and prices of our standard range of power and audio transformers.

The various applications for the range of A & R voltage adjuster units are detailed in a fully descriptive, illustrated pamphlet now available.

Any of our distributors will be pleased to supply this literature on request.

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"thinness" in an optical grinding machine.

After this, the slices are diced into square wafers by ganged diamond saws. This square wafer of "doped" germanium is the heart of the transistor — a germanium wafer about 3/10in square and one hundredth of an inch thick.

To make this germanium wafer into a transistor two wafers of indium are alloyed to each side of it in sandwich-like fashion.

This wafer sandwich, the transistor, is mounted onto a base onto which, in turn, is welded a stainless steel cup. In a special machine, a vacuum pulls out of this enclosing cup, damaging atmospheric components such as moisture.

Then a neutral gas is inserted in the closed cup and it is hermetically sealed.

The modern high power transistor is smaller and will handle more power than the relatively high power vacuum tubes used in car and household radios, in contrast to the minute, match-head size transistor frequently dramatised. These match-head size units will only handle infinitesimal amounts of power.

The life expectancy of transistors has not as yet been determined and physicists hesitate to say what this might be. They are confident, however, that transistors will provide many more years of use than the more delicate vacuum tubes.

★ ★ ★

UNDERGROUND PETROL STORAGE

Faced with the problem of providing storage for over one million barrels of light petroleum products, the Esso Standard Oil Company of America has adopted a novel solution. It is proposed to scour huge cavities in a layer of natural rock salt which occurs at a depth of 2,000 ft. below a solid layer of impervious rock at Sorrento, Louisiana.

THE cavities are formed by drilling a borehole as far as the salt bed and then leaching out the soluble material with fresh water until the calculated amount of salt has been removed.

Petroleum gases in liquid form are then pumped in and float on the surface of a brine layer. To remove the stored material more brine is pumped in to displace the required volume, so that the cavity is always kept full of fluid.

Five such stores are projected, two of 150,000 barrels capacity, one of 200,000 barrels and two of 300,000 barrels. The smallest will measure approximately 850 feet deep and some 35 feet in diameter.

Rock salt cavity storage is eminently suitable for petroleum products because salt forms an excellent seal and will not contaminate them.

Butane, propane, ethylene and propylene will be stored to even out the fluctuations of supply and demand, and to meet the ever increasing call for ethylene and propylene as raw materials for petro-chemical production.

A NEW 110-DEGREE CRT TUBE

The new 21CEP4 (right) has the same size screen as the conventional CRT (left).

The day when we suffered our T.V. tubes to project beyond the back edge of the cabinet may be numbered. This new design has reduced the length of a 21-inch by 6 inches with better quality and brightness.

NOW under regular production at the R.C.A. tube plant in Marion, Indiana, is the first commercial 110-degree picture tube in the 21-inch size, the 21CEP4.

Its appearance marks the culmination of efforts initiated as far back as 1952, when this manufacturer began to investigate the practical feasibility of increasing the deflection angle beyond 90 degrees.

By July, 1954, it was decided that an angle of 110 degrees was a realistic commercial objective; that is, a CRT deflecting through such an angle could be designed without requiring such alterations in associated circuits and components as to result in unrealistic receiver prices.

Little more than two years later, in October, 1956, the design now under production was incorporated in the 17BZ4.

The 21CEP4, weighing in at 22lb and measuring 14¾ inches long, incorporated several features developed over the years during which the project has been under way.

NECK DIAMETER

In addition to the determination that 110 degrees was the optimum angle, 1 1-8 inches had been selected some time ago as the optimum neck diameter.

Also, extensive work was done on determining the actual electron-beam paths in a picture tube, involving the use of some unique techniques. This research was necessary to arrive at the shape for the tube that would not obstruct the electron beam.

Out of these investigations came the parabolic contour presently associated with the new family of wide-angle cathode-ray tubes.

Other features found in the new line of picture tubes include a glass-button base, a straight electron gun that operates without an ion trap, and an aluminium backing on the screen of carefully controlled thickness.

The base of the tube combines the narrow pins used in miniature tubes with the plastic positioning key found on octal tubes. It should substantially reduce the number of otherwise usable picture tubes that must be replaced because of loose bases or poor base connections.

PRE-FOCUS LENS

In using a straight gun, although ion burn can be avoided with proper aluminisation, there is the additional danger of damage to the cathode with consequent shortening of tube life.

A unique pre-focus lens, which gives superior focus and definition and is relatively insensitive to voltage variations, avoids contamination.

In an extended life test 285 of the new tubes were subjected to 4,000 hours of use. Results indicate average emission life superior to that of conventional tubes.

Costs to the manufacturer for the 17- and 21-inch sizes range about two dollars more than for 90-degree tubes. Since only about 15 per cent. more deflection power and " B plus" power are required from the receiver, no additional power requirement is made on present conservatively designed sets.

A 24-inch version is planned for early commercial availability.

A typical example of traffic "clovers" and overpasses on the Hollywood-Santa Ana Freeway in California showing how the elimination of cross-sections allows high-speed traffic to continue unimpeded. Once on the highway vehicles do not stop for anything. Their destination reached, they "peel off" to a "clover" or side road.

The New Science Of Traffic Control

The speed and volume of traffic along modern highways are creating tremendous problems for scientists and engineers. Europe and America have shown us how our own difficulties must be met if we are to avoid the complete saturation which threatens us. Our country is desperately in need of better ground communications.

by Calvin Walters

THIS new branch of engineering has been named Traffic Engineering, for it is entirely devoted to the study of traffic problems, and the improvement of the flow of traffic on highways and terminals. It is not to be confused with HIGHWAY ENGINEERING, which is the science of ROAD AND HIGHWAY CONSTRUCTION.

The fundamental aim of traffic engineering is to achieve the best traffic performance on existing roads by so applying scientific and engineering principles.

It aims to plan new roads and highways so that they will adequately cope with all traffic requirements at all times.

In short, traffic engineering attempts to provide a free flow of traffic with a minimum of accidents and casualties and congestion.

The traffic problems of almost every large city in Australia are most acute. This is because most cities were designed in days when the motor vehicle was never thought of. That such a vast increase in the use of motor vehicles, since their invention, could occur was not foreseen.

Today, almost every aspect of our lives is influenced by the flow of traffic on our roads.

The cost of living is directly affected by the congestion which exists on roads to and from cities. Wastage of man hours and fuel is enormous. This in turn affects the growth of cities and retards development.

Traffic engineering begins with a study of traffic characteristics, so that improvement of traffic performance on existing roads can be brought about by regulatory methods.

It collects facts relative to traffic operations, which are then analysed. From the analysis, a knowledge is gained of all the diverse qualities of traffic under all conditions.

TRAFFIC ANALYSIS

The traffic on any highway is of a very complex nature, for it involves such matters as human nature and the laws of time, space and motion.

The driver and his vehicle is the main unit in any traffic. Thus the main characteristics of traffic involve the abilities, performance and the requirements of both the human being as a road user and the vehicle itself.

Other characteristics which have a vital bearing on the study of traffic are speed, volume, origin and destination, distance, direction of movement, intersection flow and flow of the traffic stream. The characteristics of accidents are also studied because these are the indications or measure of failure.

As, therefore, the Traffic Engineer must deal with the human element or the road user, traffic engineering must also cover the study of psychology. Likewise, because the vehicle is an important factor on the roads, the engineer must study the physics relating to the behavior and performance of the vehicle.

Similarly, he must study the mathematics required in analysis of statistics, the detail of planning, the economics of government and the theory of road and highway construction, including the physical nature of materials used therefor.

It will thus be seen that the science of traffic engineering is a very comprehensive science requiring great skill and organisation of method.

It is impossible here to cover all the aspects of methods used by the traffic engineer. Rather will we touch on some of the surprising and little known results of the study of highway traffic.

As the vehicle cannot use the roads without a driver, the latter is obviously

SPEED AND SAFETY IN CROSSINGS

the most important factor in highway problems.

The driver is activated with some purpose. He is intent on going somewhere either for business, social or recreational purposes. He enters the traffic stream governed by five factors, namely time, place, route, origin and destination.

The behavior of the road user depends on his individual characteristics of intelligence, skill, emotion and physical condition.

As vision is the factor which, more than any other, influences the road user to take certain action in his driving, this is the first consideration of the traffic engineer.

When a driver's eye is fixed on some point in front of him, the most acute vision is subtended by a cone with an angle of 3 degrees. Within this cone, vision is very distinct, but is also quite good within a cone of 6 degrees and only satisfactory up to an angle of 20 degrees.

VERTICAL VISION

Vertically, acute vision is only from one half to two-thirds as efficient as it is in the horizontal plane and for any fixed position it is better on the part of the retina nearest the nose.

For effective recognition by a driver it has been found that words and symbols of traffic signs must fall within an area covered by the width of the hand held at arm's length and in line with the centre of the road. (T. M. Matson). This is within a visual cone of about 10 degrees.

The limitations imposed on the driver by this restricted field of vision force him to shift his eyes about. Thus speed of eye movement is important in direct proportion to the speed of traffic.

It has been found that, in order to get clear vision in highway traffic, the eye must make six different kinds of movements, which are all time consuming.

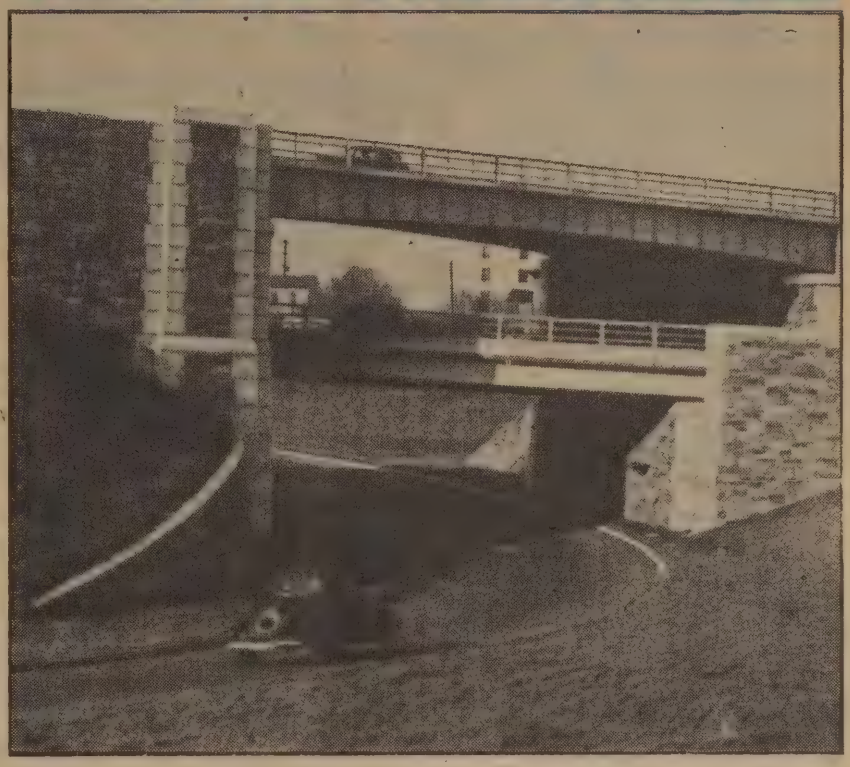
Firstly, the eye must fix on the objective. This takes about .17 seconds. Then the eye jumps from one point to another. This can take up to .33 seconds if the stimulus is outside the field of acute vision. Thirdly, the eye must follow the movements of other road users. Then both eyes must move in harmony in order that the pupils may adjust themselves to secure binocular vision on moving objects. This adjustment time can be up to .5 seconds. Fifthly, the eye moves to adjust itself for movements of the head and, finally, noise and other stimuli often cause involuntary movements of the eye.

REACTION TIME

All these time-consuming movements are vital factors in the safety of the road. If a driver fixes his eye to his left at an intersection it can take him as much as one and a quarter seconds to shift his eyes to the right and back again to the left. This is time enough for anything to happen.

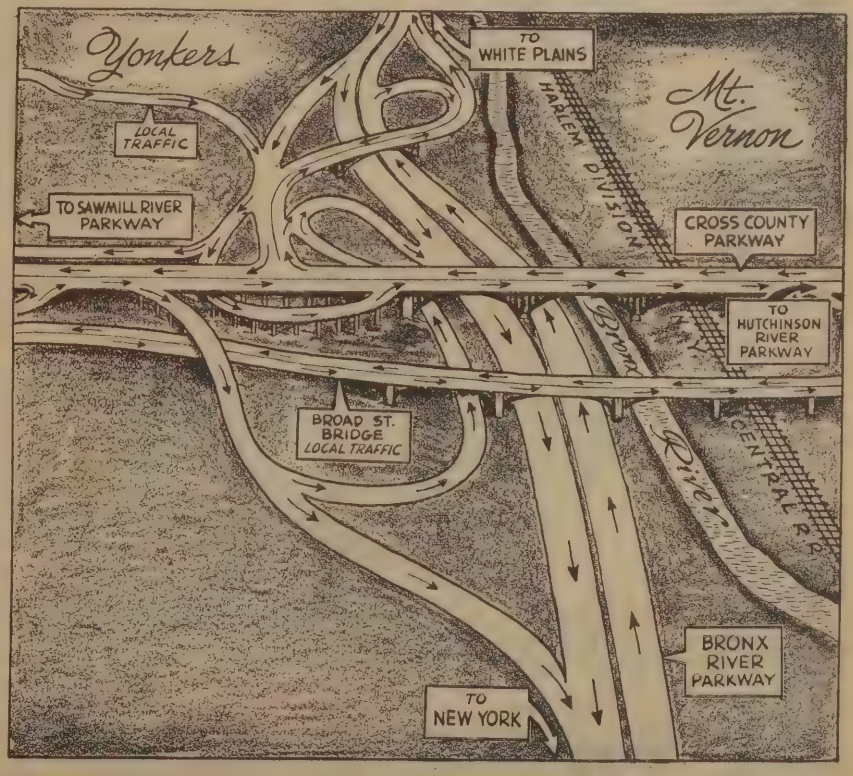
The figures mentioned do not take into account the time required for reaction, but are for seeing only.

According to K. Reid, a driver who is driving with artificial illumination requires 1.3 seconds extra for each 10 miles an hour increase in speed to obtain maximum visual perception of traffic conditions. He loses, on an average, 20 feet loss of visibility for each 10 miles an hour increase in speed.



This three-level bridge on a busy highway outside Washington D.C. eliminates a dangerous corner and saves an enormous amount of time.

Everyone knows that one can see "out of the corner of the eye." This field of vision is called the Peripheral Field.



How a complicated highway system is planned. This one solved a hopeless traffic jam near New York.

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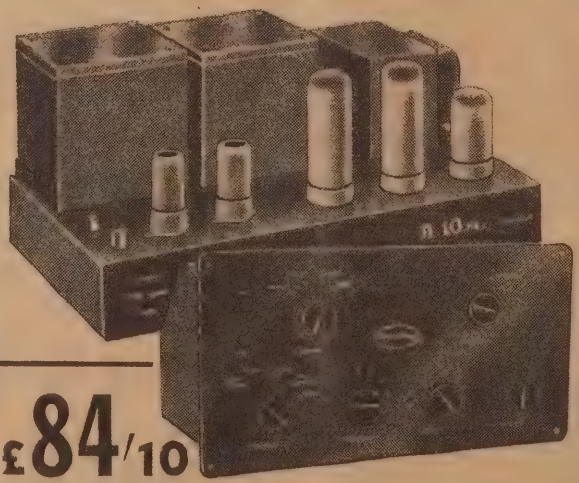

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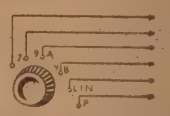
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In this field, objects are not clear outside the aforementioned 10 degree cone of acute vision. Rather does one merely discern that something is there or going on. You can, for instance, "see" someone getting off the footpath on to the road. If you were to move your eyes to bring the object into the clear field of vision it would, including reaction time or the time taken to think, take about .5 of a second. It will take longer if you also move your head.

The total "peripheral field of vision" of the two eyes varies in individuals from 120 to 160 degrees. This shrinks the faster you go. It is about 100 degrees at 20 miles per hour, but drops to 40 degrees at 60 miles per hour. Thus the faster the travel the less one can see "out of the corner" of the eyes.

COLORED LIGHTS

Traffic engineers therefore take this into consideration and do not rely on side vision but on the field of acute vision when designing traffic regulations and the position of signals. They see that all traffic signs or signals are not so complicated that they require too great a degree of visual concentration.

The proper design of coloured traffic lights takes into account the color blind person's inability to distinguish between red and green. The inclusion of some yellow in the red light and blue in the green light assists the color blind to distinguish the colors. The standard relative positions of the red, yellow and green light is also of assistance.

Traffic engineers take into account the time required for the pupil of the eye to expand and contract according to the amount of light entering the eye. They found that the eye adapts itself much quicker when entering light from darkness than when entering darkness from light.

It will be appreciated that night driving imposes heavy demands on the eye because of variations in street illumination, electric signs, glaring headlights and so on. As the driver gets older and if he wears spectacles, he finds it more difficult to adapt his eyes to overcome glare difficulties. Heavy cigarette smokers also sometimes suffer from this defect because of the iris of the eyes becoming partially paralysed by nicotine.

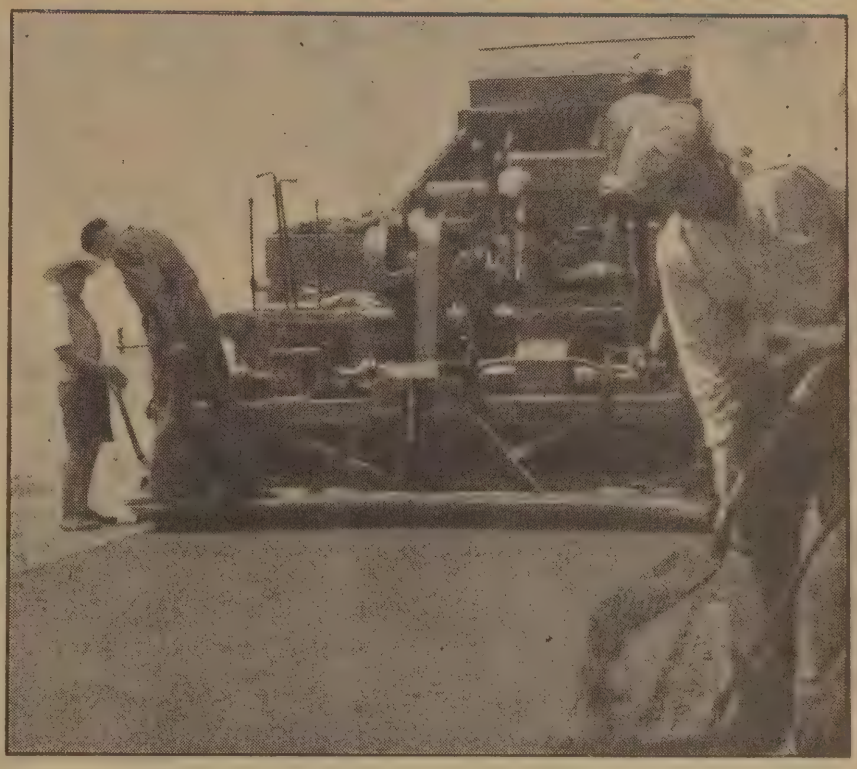
PIEV TIME

What is your PIEV time? This is a new term coined by traffic engineers. They find that every act that a road user performs is dependent on the exercise of Perception, Intellection, Emotion and Volition, the first letters of each of which spell PIEV. The total time taken for all these to act is the PIEV time.

Sensations which are strong enough to be recognised are called "perceptions." They may be received through the eyes, ears or the body. The time taken for the process to act on the brain is the perception time. It varies according to the experience, psychological and physiological characteristics of the individual.

The forming of new ideas based on previous experience coupled with new experiences and the time taken for comparing, regrouping and registering for later use is called intellection. It results in the sending of impulses over the nervous system to the glands and muscles. The recognition of an unusual hole in the road together with its comparison of another hole one encountered somewhere else and what one did about it and the difference between this one and the other is intellection. It acts quite unconsciously. The time taken for reaction is the intellection time.

MACHINES ARE KEY TO FAST WORK



Big road making machines such as this one apply and bake the road surface in a single operation. In the USA there are now machines several times this size which can lay down an entire concrete highway.

EFFECTS OF EMOTIONS

The emotional characteristics of the individual are an important factor in traffic. Fear or anger, as everyone knows, governs to a great extent the behavior of drivers in traffic.

Volition is the will to take some definite action and is the result of the resolution of all previous impulses into a decision to act.

PIEV time therefore is the total time for all the above to act so that a decision may be made. This time has been found to range from .5 seconds for simple problems such as to pull up in a certain position at a traffic light, to anything from 3 to 5 seconds for a more complex problem such as the decision to overtake another vehicle.

Fatigue lengthens PIEV time. This can be caused not only by physical weariness, but by glare, monotony and the effects of rhythm. Traffic engineers avoid monotony, rhythmic and glare sources when designing roads and lighting.

Any disease, or other disabilities such as deformities, alcohol and drugs increase PIEV time.

Climate, weather, altitude, time of day, season, ventilation, light and so on all have their effects on PIEV time. High temperatures and humidity cause high tempers and irritability, as also does the weather such as rain and snow. Mental and physical efficiency depend on the oxygen taken into the lungs and this depends on the amount of ventilation or the altitude. Colors of lights also have their effects. Variations in road surface such as alternating good and bad patches have effects on behavior.

Traffic engineers have found that, in almost every traffic situation, fear and self protection are the fundamental factors. Competition such as the "me first" attitude leads to anger and so on.

As the process of thought is "one thought at a time" traffic engineers try to place traffic signs so that the choice of the driver is limited to as few paths as possible, preferably to a single choice. This limitation of choice causes less frustration in complex traffic problems and leads to an easier flow of traffic.

CONDITIONING

There is one condition which often leads to accidents. This is known as "conditioned response." An example of this is the driver who, after travelling long distances at high speed, becomes what engineers call "velocitated." The driver will not reduce speed until some very strong stimulus forces him to do so, such as traffic entering a city or a sudden bad road.

Another example of this is the tendency, over a long drive, to follow some road marking or monotonous

Continued on Page 119

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Technical Review

SYNCHRONOUS SPOT WOBBLE IMPROVES DEFINITION

British engineers have always been interested in methods of improving their 405-line T.V. definition. This article from Wireless World gives a new slant on an old idea with considerable promise.

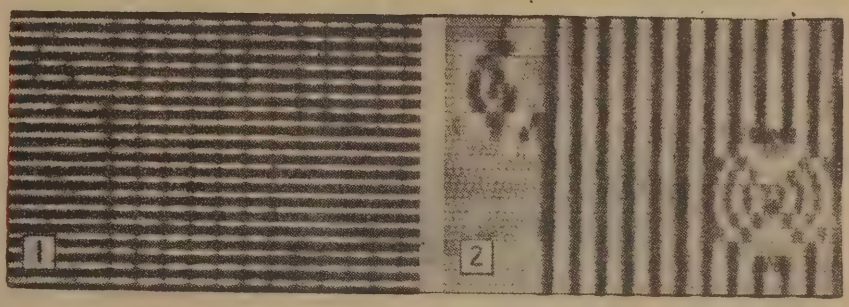


Fig. 1 shows a section of a test chart on one frame of a 405-line picture (202½ lines) without spot wobble Fig. 2 is the same section with ordinary spot wobble applied to the c.r.t. while Fig. 3 (below) shows the improvement effected by synchronous spot wobble on both c.r.t. and camera tube. A complete interlaced picture with s.s.w. is even better.

In discussions on British colour television standards it has often been suggested that a high-definition picture might be transmitted in Bands IV or V and that standards conversion might be used to obtain a 405-line version for transmission to the existing 7 million monochrome sets

Ruling out the "brute force" method of standards conversion (a camera "looking" at a monitor tube) on grounds of picture degradation, the direct electronic system proposed by H A Fairhurst comes to mind

This, and most other proposals tacitly assume that the high-definition picture will have a greater number of lines than the 405-line standard There is, however, the interesting possibility that the high-definition picture might itself be 405 lines, but with increased resolution and bandwidth.

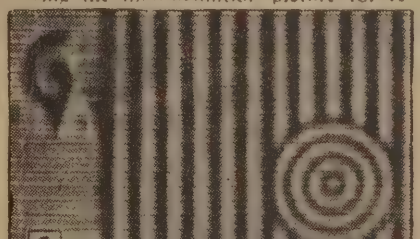
The normal-definition 405-line picture could then readily be extracted from it by sampling at a rate appropriate to a 3-Mc/s bandwidth

This suggestion emerged from a lecture on a new system of television recording given recently to the British Kinematograph Society by A. E. Sarson and P. B Stock, with an historical introduction by L. C. Jesty

The new system is based on the well known suppressed-frame method of recording on film, but it avoids the loss of picture information normally associated with using only alternate television frames by starting off with a 405-line picture of high definition.

The 202½-line television frames recorded on successive film frames then contain much more information than they would with the normal definition, and when subsequently the film is scanned for transmission a much better picture is obtained.

Of course, since the camera chain giving the high definition picture for recording is also the means of producing the "live" program, a 405-line picture of normal definition has to be extracted for transmission, and this is where the sampling process is used.



The increase of definition without extra lines is obtained by a technique known as synchronous spot wobble. With ordinary spot wobble the idea is simply to fill in the spaces between the lines, and this is particularly necessary on suppressed-frame recording where each film frame records only 202½ lines and there is no subsequent interlacing

As an example, Fig. 1 shows a section of a 202½-line frame and Fig. 2 how it is improved when ordinary spot wobble is applied to the c.r.t. The main drawback of ordinary spot wobble, however, is that it displaces picture information which should appear at only one point on the screen so that it also appears at other points. This produces among other things a stepped effect when diagonal or curved lines are scanned, as shown in Figs. 2 and 4, with consequent deterioration of picture quality

With synchronous spot wobble, however, these effects are avoided. The alternating wobble voltage is applied to the camera pick-up tube as well as to the monitor c.r. tube, and is synchronised in frequency and phase at both ends.

The result is that the scanning spot has an increased path length and covers a greater area of picture detail than normal during the period of one line. Because of this higher scanning speed, information is transmitted through the closed-circuit system at a higher rate than normal, so that a larger bandwidth is required.

In addition to filling in the spaces between the lines, the synchronous spot wobble gives a vertical "exploratory" component to the horizontal scan, with the result that the vertical resolution of the complete picture is increased. Actually the spot-wobble scanning is such

(Continued on Page 27)

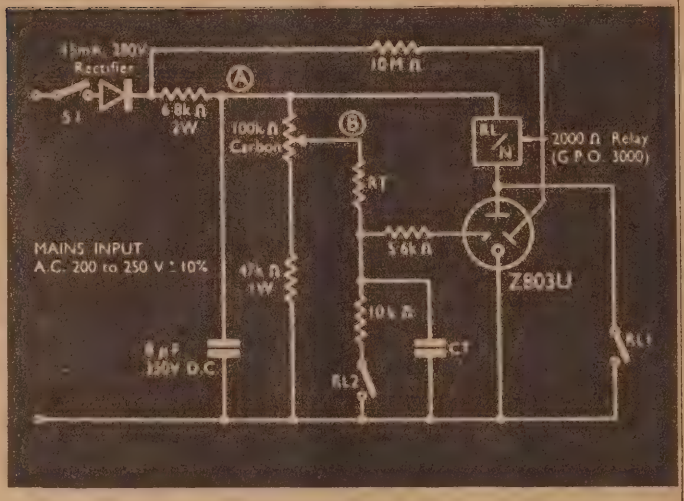
☆

Fig 4. When scanning diagonal bars (left) ordinary spot wobble gives a stepped effect (centre) but synchronous spot wobble fills in the spaces with genuine picture information (right).

FOR TIMER SIMPLICITY AND ACCURACY

Z803U

TRIGGER TUBE



The Z803U trigger tube can be used for a variety of timer, voltage control and general relay applications. It has an extremely stable trigger voltage over a very long operating life and offers the advantages of all Mullard cold cathode tubes — no heater supply requirements, no waiting for "warming-up" and good mechanical strength.

Typical of the applications of the Z803U is the simple interval timer described here which can cover the range between 5 seconds and 10 minutes. It may be operated direct from any a.c. mains supply between 200 and 250 volts.

To start a timing sequence the mains supply is switched on (S1). The d.c. voltage at point A will then rise, in about 100 milliseconds, to between 184 and 282 volts, the actual level depending on the value of the local mains voltage. The timer capacitor CT will start to charge up through RT, the timer resistor.

When the voltage on CT reaches the critical trigger voltage of the Z803U the tube will fire, pulling in the relay, partially discharging the 8 microfarad smoothing capacitor, and lowering the voltage at A.

The relay will self lock on contact RL1 thus extinguishing the Z803U, and the relay current will then be limited by the 6.8 k Ω series resistor. Contact RL2, which should make after RL1, re-sets the timer capacitor to zero volts.

However, the relay drops out only when S1 is opened. A new sequence can then be started on reclosing S1.

The 100kΩ preset potentiometer allows the timing circuit voltage to be set up so as to compensate both for component tolerances and for the value of the local supply voltage. The pre-firing voltage at point B will be about 170 volts.

The values of RT and CT will be set by the required time interval T', and can be determined from the fact that T' = 1.6 RT.CT.

RT should be a high stability resistor, while CT must be a capacitor with a small power factor, e.g., a paper or plastic film capacitor. All other components are of ± 10% tolerance.

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RADIO PILL BROADCASTS FROM YOUR STOMACH

A "RADIO PILL," an encapsulated FM transmitter that can be swallowed and is used to "telemeter" information from the digestive tract, was demonstrated recently at the Rockefeller Institute in New York City. Its action was explained by Dr. Vladimir K. Zworykin, affiliate in biophysics in the Medical Electronics Centre of the Rockefeller Institute and honorary vice president of RCA, who had been active in the early stages of its design.

A "radio pill" offers the medical man many possibilities since it causes no discomfort to the patient and thus can make measurements under more normal conditions than older tools.

It can easily penetrate such areas as the right side of the colon, hitherto almost inaccessible to study.

PRESSURE MEASUREMENT

Present models (only three were in existence at the time of the demonstration) have been used to measure pressure. Temperature measurements are also possible, and it is expected that means will be devised to measure acidity in the gastro-intestinal tract.

The transmitter consists of a ferrite cup core, two coils, two resistors, two capacitors, a transistor, and a small rechargeable 1.5-volt cell in a plastic capsule 1 1/8 inches long and 0.4 inch in diameter.

Operation is at approximately 1 mc, and the signal is receivable for a foot or two outside the body.

The unit is frequency-modulated by a disc-shaped magnetic shunt, which changes the inductance of the core as it moves closer and farther away. Since frequency modulation is used, changes in amplitude caused by the unit moving nearer to or away from the body's surface create no reception problems.

THE TRANSDUCER

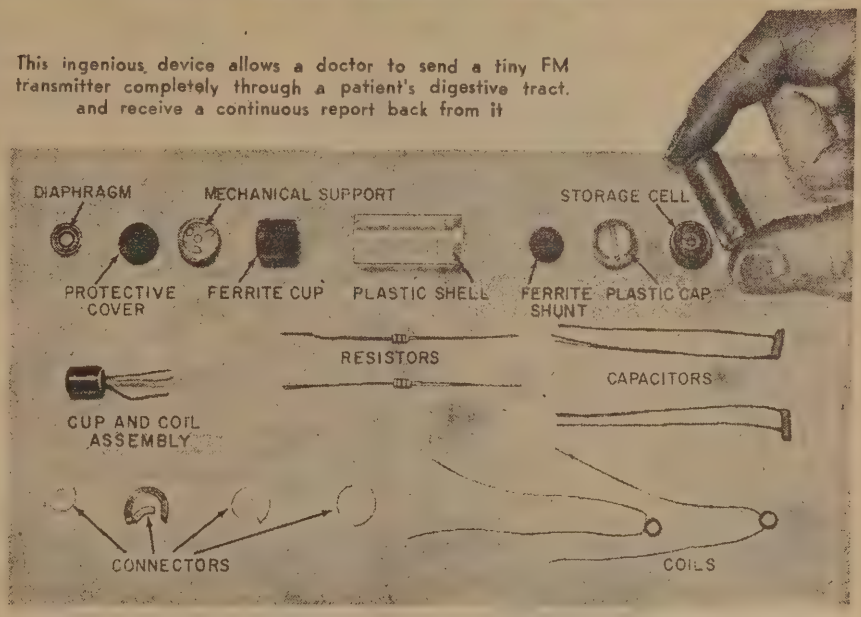
The pressure transducer consists of a rubber diaphragm (a metal diaphragm was used in the first model, shown in exploded form in the photograph) to which the magnetic shunt is attached.

As pressure is increased, the diaphragm is bent inward, forcing the shunt nearer to the core and lowering the transmitter's frequency. A second diaphragm is provided at the end of the tube, for mechanical protection.

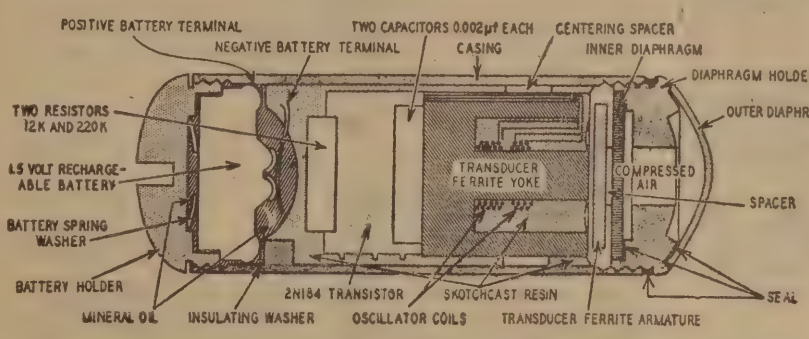
The space between the two is filled with air, under enough pressure to make the whole space act as a piston, transmitting the pressure from one diaphragm to the other without significant loss.

The idea of such a pill was conceived by John T. Farrar of the Rockefeller Institute and its design worked out by Dr. Zworykin. The development work was done by a team of engineers of RCA's Commercial Electronics Products Division in Camden, N.J.

This ingenious device allows a doctor to send a tiny FM transmitter completely through a patient's digestive tract, and receive a continuous report back from it



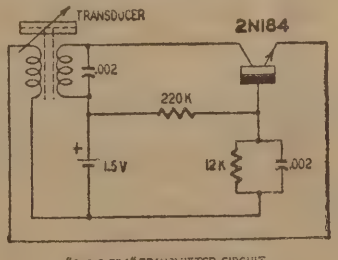
These components all go together to make up the 0.4 inch diameter 1⅛ inch long. Radio Pill that telemeters information from the digestive tract.



Cross-section diagram of the capsule containing the FM transmitter.

A remarkable feature of the apparatus is that it was constructed from available miniature components. Even the battery was found on the market. The constructors did not have time to get special components made for the job and had to rely on standard parts. With specially made components, an even smaller capsule could be built.

In its present stage of development, the radio pill must be considered an experimental technique but one which holds important implications for future medical research. The pill's practical uses will be evaluated following laboratory tests and experiments.



"RADIO PILL" TRANSMITTER CIRCUIT

Circuit of the transmitter.

Studies involving use of the radio pill, for the time being at least, are being carried out in the New York Veterans Hospital with the patient under continuous observation. Preliminary testing has taken place during the last year.

—RADIO ELECTRONICS.

INVISIBLE ANTENNA

AN American company has acquired patent rights to an antenna that has no towers, rods or wires.

The antenna is actually a long column of ionised air produced by an x-ray tube or by radioactive elements such as uranium or radium.

The shaft of charged atoms serves as a conductor and can receive or transmit high-frequency signals.

Because of the power and equipment needed, the invisible antenna probably will be used in industry rather than on household television or radio.

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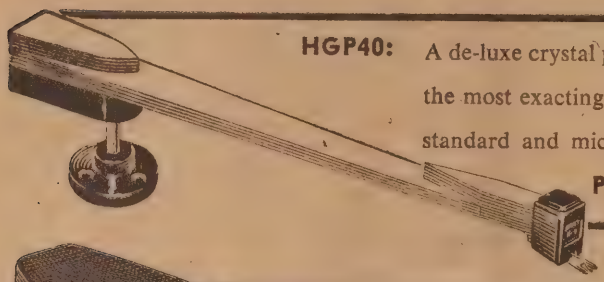

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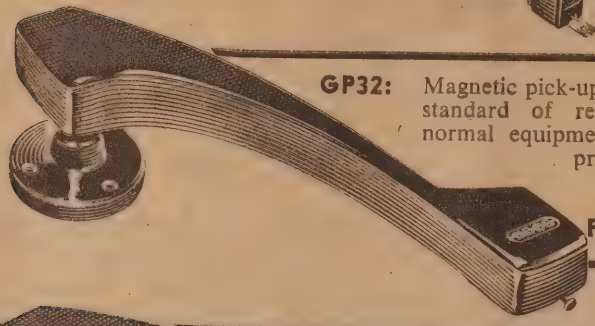

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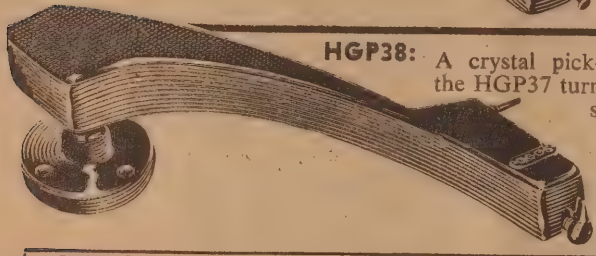

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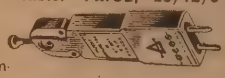
GP9 CARTRIDGE



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NEW LONG LIFE T.V. RECTIFIER

The first line of germanium rectifiers specifically designed for T.V. power supplies is being incorporated in new T.V. receivers just reaching the market or about to reach the market in the U.S.A. The new semiconductor units are being produced in quantity, at prices competitive with selenium rectifiers.

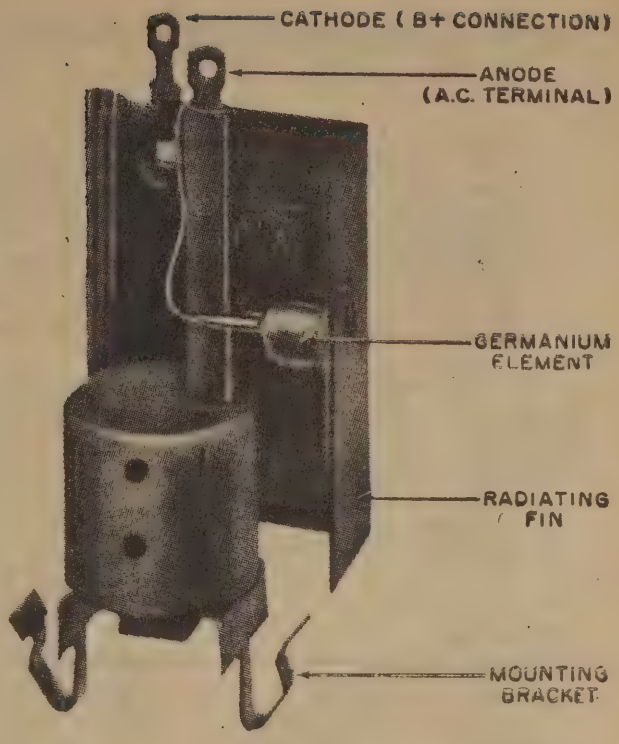

Fig. 1: The 1N573 germanium rectifier is shown here almost twice actual size

EQUALLY as important as the news that these units are being incorporated in original equipment is this follow-up announcement: these germanium power diodes are also being made available in a form that will permit use as replacements for the more conventional selenium diodes found in countless receivers already in use.

There is nothing new in using germanium as the element in a crystal rectifier. Historically, this material antedates selenium in such a role.

Also, it has been known to enjoy certain advantages over selenium. However, until recently developed production techniques cut back the cost of manufacture sharply, germanium rectifiers could not be made available at the voltage and current ratings required for use in T.V. and radio power applications except at prohibitive prices. These new units are competitively priced.

The first three rectifiers to appear in the line are RETMA types 1N573, 1N575 and 1N581. The first is a half-wave unit that delivers 250 ma. of d.c. output. The 1N575, also a half-wave rectifier, is designed for a 350-ma. output. The 1N581, consisting of two rectifiers already connected in a voltage-doubler configuration, is rated at 250 ma.

LOW VOLTAGE DROP

Full-cycle average full-load voltage drop for these devices is very low: a maximum of .15 volt for the 1N573 or the 1N581 and a maximum of .3 volt for the 1N575. Maximum peak inverse voltage ratings of 380 volts apply to all three. Also, each of them is designed to be used with a 4-ohm surge-limiting resistor. The units are hermetically sealed in metal cases and are warranted for one year.

Physically the units are smaller and lighter than their selenium counterparts and, even at the small size of the entire unit (see Fig. 1) most of it consists of a radiating surface or heat sink and a mounting bracket. The actual germanium element is much smaller than a dime.

On the rectifiers being supplied to set manufacturers the mounting bracket is a mechanical snap-in type to keep chassis assembly costs down and also to streamline later replacement. The types being produced for field replacement of selenium rectifiers are electrically identical to these but have brackets that will permit direct mounting, where conventional selenium devises were used, without any physical alteration.

In germanium rectifiers, as in the silicon rectifiers introduced more than a year ago, there are only the crystals of a single element to deal with, rectification taking place within this element rather than at a junction. It is therefore much easier to control production of germanium rectifiers.

No circuits for germanium-diode power supplies are shown because these configurations are entirely familiar; they are identical with supplies using selenium rectifiers.

Load capacitors in the filter circuits used for the germanium devices are recommended to be in the range from 100 to 300 uFd. Where selenium-to-germanium replacements are being made clearly no changes are needed here

The 4-ohm minimum value for the surge-limiting resistor required for any of the germanium units now available is less than that required for comparable selenium rectifiers, so there will not usually be changes in this item—except where the technician may wish to take advantage of the slightly higher "B plus" made possible.

Typical voltage-regulation curves, shown in Fig. 2 for a 1N573 germanium diode with various values for the capacitive load, tell an interesting story when compared to a curve for a comparable selenium unit.

With the lower internal voltage drop the germanium rectifier begins by yielding a greater output voltage to the external circuit and, as drain by the circuit is increased, voltage output from the germanium power supply holds up much better

To the service technician the switch to a germanium rectifier means a convenient solution to many elusive problems where critical operation is associated with marginal "B plus" supplies or drops in line voltage.

To the set owner, the high reliability of germanium rectifiers and the long life that may be expected of them will be welcome. The new units are expected to outlast their receivers.

Since selenium rectifiers age with use, showing decreased output as time goes on, they have to be derated for use in equipment.

This is to say that when a unit is being selected for use in a particular

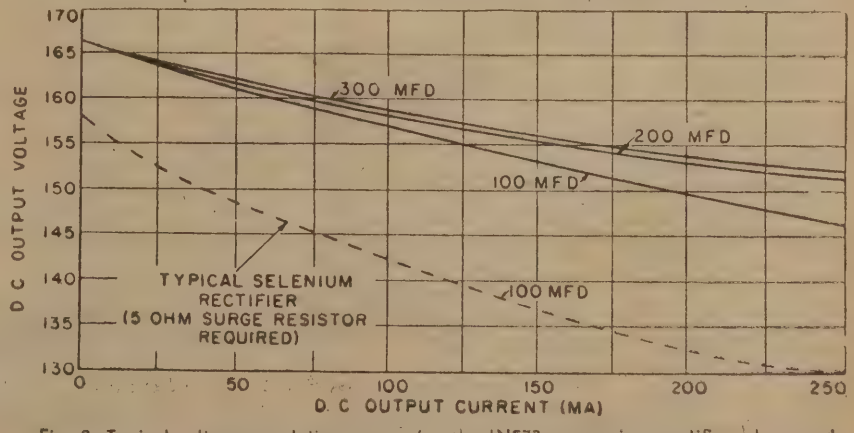

Fig. 2: Typical voltage regulation curves for the 1N573 germanium rectifier when used in a half-wave circuit with capacitive load, for three values of capacitance. A comparable curve for a selenium rectifier is also included.

TEST EQUIPMENT *from "Audio Engineers"*

Oscilloscope Model 32A

This is a versatile Oscilloscope primarily intended for T.V. and Radio Service work, but having outstanding performance and many features which make it invaluable for general purpose use wherever an Oscilloscope is required. It has a 4in flat faced C.R. Tube.

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piece of equipment it is chosen to be over-sized in the electrical sense, so that it will still be useful in the circuit as its rated capacity to deliver voltage and current falls off.

Since there is no aging problem with germanium rectifiers a germaniun unit that is used to replace a selenium unit may safely have a lower nominal rating

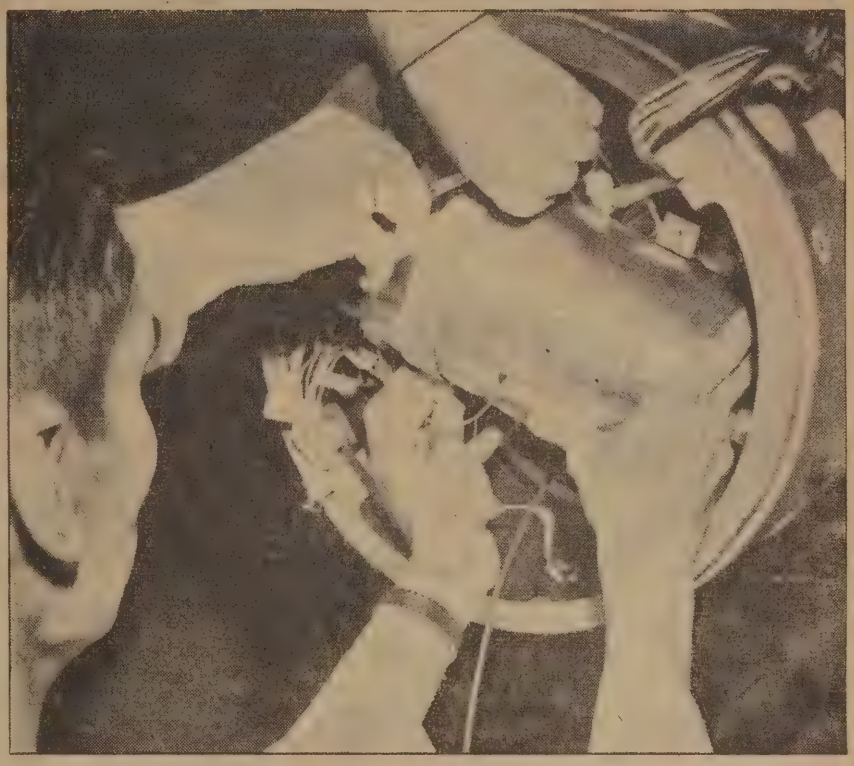
An actual example of this difference in rating for comparable units is taking place in current G-E production of its line of 17-inch portable T.V. receivers

The original circuit called for a pair of selenium diodes rated at 300 ma. each Newer models use a pair of germanium units rated at 250 ma. each. For the technician planning a substitution, the best bet is to measure current drain on the rectifiers to decide on the current rating of the replacement unit rather than to use the rating of the selenium device as a guide.

As for testing when a defective rectifier is suspected, the procedure is similar to, but simpler than, that used for a selenium unit. Forward and reverse resistance readings, taken directly across the diode with an ohm-meter, are compared, but no critical readings are given as standards.

Aging or loss of efficiency do not occur with germanium rectifiers. A short is the only type of defect that can occur. Therefore, if resistance readings taken in both directions are low, the unit is shorted and should be discarded. In all other cases the rectifier may be considered as still good.

HEART OF AN EARTH SATELLITE



A working model of the earth satellite's heart being placed in the nose of Aerobe-Hi rocket by a U.S. Navy scientist. In the metal cyclinder are numerous recording devices which will send messages back to earth It is the heart of the enterprise.

SYNCHRONOUS SPOT WOBBLE IMPROVES DEFINITION

(Continued from Page 21)

that the improved definition is shared between the vertical and horizontal directions.

Fig. 4 (right) shows diagrammatically how the scanning of diagonal bars is improved by the use of synchronous spot wobble, while Fig. 3 demonstrates it on an actual screen picture of the section of chart in Figs. 1 and 2.

Instead of just filling in the gaps between lines with spurious picture information, as with ordinary spot wobble, the new system adds genuine information which was previously missing. Of course, the price to be paid for the improvement is the increased bandwidth, but this does not matter in the closed-circuit system used for recording purposes.

A spot-wobble frequency of 6 Mc/s has been found satisfactory, and this demands a video bandwidth of at least 6 Mc/s and preferably 9 Mc/s. In practice the spot-wobble scan produces the effect of a 6 Mc/s sub-carrier on the video signal, which is modulated by the line sync waveform and the picture information to form sidebands extending up to 3 Mc/s on either side.

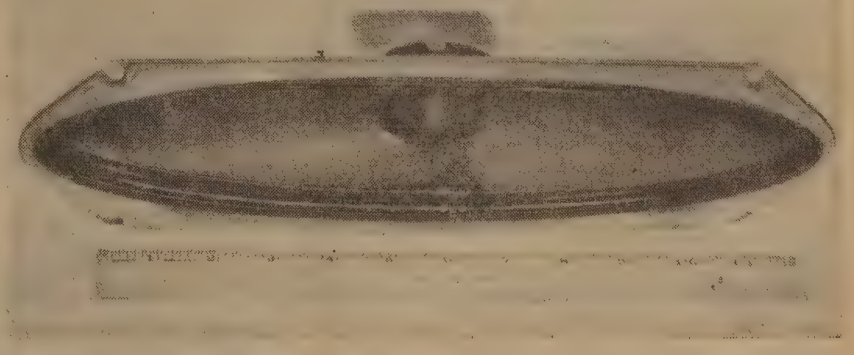
To extract the "live" television picture from the high-definition closed circuit for transmission at normal 3 Mc/s definition, a sampling p.r.f. of 6 Mc/s is required (according to the well-known Hartley law). If the samples are of sufficiently short duration, and they are smoothed afterwards by passage through a 3-Mc/s low-pass filter, the "contaminating" effect of the vertical component in the synchronous spot wobble is removed and the resulting picture is practically indistinguishable from one generated in the normal way.

Of course, if the high definition 405-line picture were actually transmitted in a wideband public service, instead of just being confined to a recording closed circuit, some means would have to be adopted for synchronising the spot wobble in the domestic receivers with that at the studio camera.

Probably this could be achieved by transmitting a "burst" of several cycles of spot-wobble frequency as a phasing signal on the back porch of the existing line sync pulse—as is already done in the N.T.S.C. colour television system. (In fact, the "burst" might easily serve a double purpose in a 405-line high-definition colour service.)

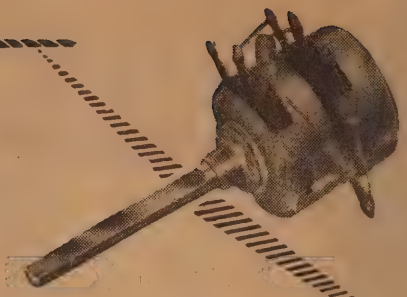
A picture composed of two interlaced frames with synchronous spot wobble is, of course, a good deal better than the single frame in Fig. 3.

NEW ELONGATED SPEAKER DESIGNED FOR T.V.



This unusual loudspeaker made by Rola (U.S.A.) measures 14 x 3 inches and is intended for front mounting in T.V. cabinets. Performance is claimed equal to that of a standard 8-inch speaker and comparable with many 10-inch types.

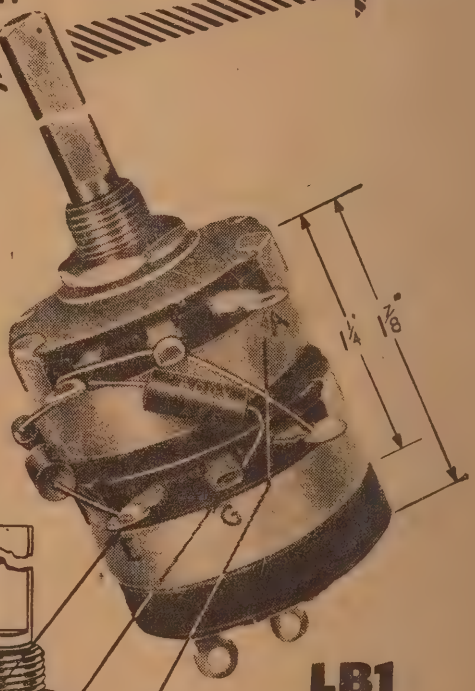
IRC AUSTRALIA



FIT New type LB1 Continuously Compensated Variable LOUDNESS CONTROL TO YOUR RADIO OR AMPLIFIER

...and automatically keep the proper balance of all frequencies within the audio range at ANY listening level!

(Patent Applied for No. N11262)



LB1

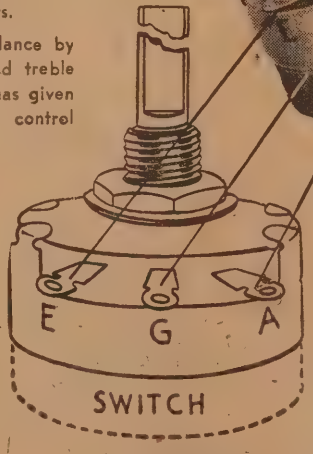
For many years there has been a need for a volume control in audio systems which would automatically keep the proper balance of all frequencies within the audio range at **any** listening level. I.R.C. has developed such a control, known as the LB1, to meet this need.

With the loudness control it is possible to reduce the output volume of any good or average audio system to a whisper and still be able to hear every tone with perfect balance, as the LB1 **provides gradually increasing high and low frequency boost** as the volume is reduced to offset the deficiencies of the human ear, **which is insensitive to high and low frequencies at low volume.** This accounts for the reason why many audio systems are operated at such high levels to give the best listening effect and in this process they become annoying to other members of the household and neighbours.

Many attempts have been made to obtain correct tonal balance by means of tapped volume controls, various types of bass and treble boost circuits and stepped type loudness controls, but none has given the performance of a truly continuously variable loudness control such as the new I.R.C. LB1.

The I.R.C. new loudness control consists of two separate volume controls operated from a single shaft of standard size and used with a combination of capacitors and resistors which are already wired. The unit will replace any volume control by transposing 3 simple connections, as indicated by the illustration at right. Can be fitted without experience.

Contact your usual supplier for illustrated literature.



PRESENT VOLUME CONTROL

NOTE:

The automatic compensation of the LB1 eliminates the necessity for a tone control.

AVAILABLE in 1 meg. 500,000 ohms, with or without switch. Other values to special order.

PRICES

With D.P.S.T. Switch 32/6; Without Switch 26/6. Available only from your usual supplier.

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Please forward Loudness Control pamphlet giving detailed description and installation instructions.

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NEWS AND VIEWS OF THE MONTH

New gear for airports

SYDNEY and Melbourne will soon have extra radar facilities to help them handle air traffic more quickly.

The equipment, known as surveillance radar, will allow one man to handle up to 26 aircraft per hour.

The present rate is 19 aircraft per hour.

The new equipment will reduce the time required to handle each aircraft as it takes off or comes in for landing.

It will be fitted with a screen which will display all the aircraft within the approach area at the one time, covering a radius of 20 miles from the landing field.

The new equipment, which is made in England, will probably be installed within 18 months. Its estimated cost is £60,000.

New alpine tunnel

BY agreement between the Governments of Italy and France, a tunnel is to be built under Mt. Blanc, 11 miles in length, to provide an all-weather route through Switzerland between the two countries.

At the present time the road over the Swiss Alps is dangerous and impassable for most of the year.

Cars have to travel part of the way on railway flatcars through the existing Simplon Tunnel.

When the new tunnel is finished it is estimated that at least 300,000 vehicles per year will use it. France will pay more than half the cost, Italy most of the rest and Switzerland the remainder.

Total cost will be about £15 million.

Radar auto brake

IN Chicago an automatic brake for motor cars, operating on a radar principle, has been developed.

An experimental vehicle equipped with the device — an antenna mounted in front — passed recent tests.

As obstacles or vehicles approached brakes were effectively applied before the driver touched the brake pedal.

Robert Moore, director of the technical and engineering division of Lumberman's Mutual Casualty Co., said:

"If all automobiles were so equipped head-on collisions of cars travelling at reasonable rates of speed might be impossible.

"Tail gating, or following the car ahead of you too closely — a leading cause of rear-end collisions — also would be eliminated."

Daddy! I've killed Robin Hood!
— T.V. Times

Atom powered navies

BRITAIN'S Navy of the future is likely to consist of task forces each with a carrier armed with atomic planes and weapons, a cruiser, destroyers and frigates.

Parliamentary Secretary to the Admiralty Christopher Soames says that while such forces would be employed in the most advantageous manner around the world, they would also be capable of concentrating at any given point.

A force of destroyers and frigates mothered by a cruiser could effectively control the sea.

By 1966 the U.S. plans to have six 85,000-ton nuclear-powered aircraft-carriers in service.

The first is due to be ready in 1961.

The Navy attaches so much importance to the "super-carrier" that it is willing to sacrifice several smaller ships in the building program.

The atom-driven giants will be as large as the biggest liners afloat to-day.

POPULAR SCIENCE QUIZ

Q: What is cryogenics?

Cryogenics is a growing branch of science concerned with extremely low temperatures and particularly the behaviour of gases at these extremely low temperatures.

Hydrogen and nitrogen for example go from a gaseous state to liquid at temperatures in the vicinity of 300 degrees below zero Fahrenheit.

Q: What happens to gases when they are cooled to these very low temperatures?

In general, they change from a gaseous to a solid state. In the liquid state they can exhibit some extraordinary properties. Helium gas, for example, turns into two different liquids at very low temperatures. One of these liquids mysteriously creeps and crawls out of its container.

Q: How are gases liquefied?

Various methods are used, some being too involved to describe in detail. The Hampson liquefier which is often used industrially to liquefy air makes use of a compressor which pumps air through a nozzle via a heat exchanger. As the gas expands through the nozzle it cools. Some of the cool gas is returned through the heat exchanger where it cools the incoming high pressure gas. The cooling process continues until very low temperatures are reached.

After a short time of operation some of the air liquefies as it leaves the expansion nozzle and falls into a vacuum flask after which it can be drawn off into vacuum bottles for storage.

Q: What are the uses of supercooled liquids?

Many of the uses probably have not yet been discovered, but the physical effects are startling and worthwhile uses for them will no doubt be found. At low temperatures, rubber becomes very brittle and will shatter if dropped. Steel becomes very hard but as brittle as glass. Lead sheet rings like a bell when struck while it carries electric current far more easily than silver which is one of the best conductors at ordinary temperatures.

Much in the same way as heat treatment improves the properties of certain steels, cold treatment can improve the durability of tool steels and improve special properties of magnetic steel. In certain assemblies, parts can be fitted easier if they are shrunk by cold first.

Liquefied gases are sometimes used instead of explosives particularly in coal mines where nitrous gases pollute the air. Containers of liquefied gases are placed in appropriate places and, when the explosion is required, quickly heated up. The liquid boils with an explosive force which is "softer" in character than most explosions and useful for some purposes.

Q: What are the electrical effects of these low temperatures?

One of the most interesting effects is the reduction of electrical resistance. It was investigated by Onnes in 1911 when he found that the resistivity of pure mercury dropped to zero at about minus 270 degrees centigrade. The same effect occurs with other conductors and it may be in the future some practical use will be able to be made of super-conductivity, as the phenomenon is called, to reduce losses in electrical circuits.

There is also a relation between magnetism and the behaviour of substances at very low temperatures and many interesting and useful effects will no doubt be discovered as scientific investigation is made in this field.

PHILIPS
SOUND EQUIPMENT

PHILIPS

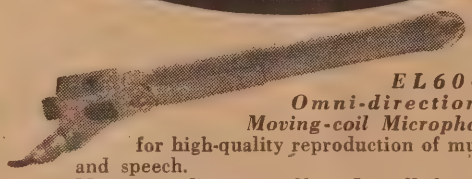
the "Key" to better sound

Philips sound equipment is designed for maximum field performance and can be tailored to meet your individual needs.
For applications ranging from industry and commerce to satisfying home entertainment the "key to better sound" is Philips equipment.

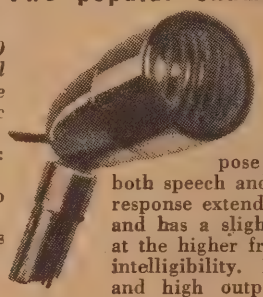
The Microphone

Philips range of microphones includes models from all-purpose crystal to the highest-quality condenser and dynamic microphones.

Two popular examples are—



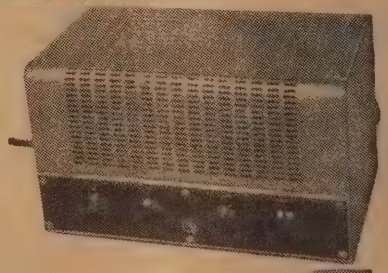
EL6040
Omni-directional Moving-coil Microphone
for high-quality reproduction of music and speech.
Maximum diameter: $\frac{11}{16}$". Overall length: $10\frac{5}{8}$". Net weight: 12 ozs.
Frequency response: Flat from 30 c/s to 20 Kc/s.
Impedance variable: 25,000 ohms, 500 ohms or 50 ohms.



1114 (Low Impedance) and 1115 (H.Z.) Omni-directional Moving-coil Microphone.
This is a general-purpose microphone suitable for both speech and music. The frequency response extends to above 10,000 cycles and has a slightly rising characteristic at the higher frequencies for improved intelligibility. Its robust construction and high output make it admirably suited for tape recorders and public address purposes.

Sound Amplification

The Philips standard range of amplifiers, booster-amplifiers and tuners extends from 2 watts to 120 watts.
Pictured is the 30-watt amplifier, whose many features are typical of the range.
It has separate bass and treble controls, separate microphone and pick-up gain controls and selection of output impedances. Suitable for operation from mains voltages between 110 V-260 V, 40-60 cycles.



Sound Distribution

The Philips range of speakers and speaker enclosures is extensive and includes such units as flush ceiling fittings, wall enclosures in metals, plastic and timber, bass reflex units, flares and horns. Featured are the types 1065/1070 sound columns. These remarkable units offer pre-calculated distribution of sound as a solution to what was previously a complex problem—difficult acoustic conditions.

For details of the complete range and further information consult PHILIPS Free Sound Advisory Service

electro-acoustic division of PHILIPS ELECTRICAL INDUSTRIES PTY. LIMITED

Sydney, Brisbane, Perth, Melbourne, Adelaide, Hobart

PG69-57

ela

They probably will have eight atomic reactor power plants, each similar to the water-cooled units in the atom-submarine Nautilus.

This will give them almost unlimited cruising range at high speed.

Artificial voice

A PORTABLE voice-box which restores the power of speech to persons afflicted with cancer of the larynx was demonstrated recently in Boston.

It works on a principle the reverse of that in a hearing aid.

Instead of magnifying sound to feed it to the ear, it condenses sound and delivers it to the mouth.

The box is about the size of a cigarette packet and operates from a tube attached to a denture.

Batteries and transistors convert sounds into electrical impulses and then transmit them along the tube to the mouth.

Noise is bounced around in the mouth and the patient can form words out of it by using his tongue, lips, teeth and other faculties as he would normally.

Quiet jet engine

AN American company has claimed that a new jet engine would operate without causing noise nuisance.

Jets have been largely unsuitable for commercial operations because many airports have barred them as too noisy.

At Quehanna, Pennsylvania, the Curtiss-Wright Corporation demonstrated the new jet engine.

The engine — known as the TJ-38 — has a 12,500lb thrust.

Bristol Aeroplane Co., Ltd., of Fulton, England, helped develop it.

The TJ-38 turbo-jet runs more quietly than any known commercial jet engine and the company claims its noise factor is quieter than some propeller-driven planes.

It operates at temperatures 360 degrees lower than other jet engines in its thrust class.

The new engine is expected to be available by mid-1958.

Rubber aircraft

IN Kansas recently, Richard Ulm unfolded a rubber aircraft from a bundle little bigger than a T.V. set, inflated it, fixed a wooden propeller and took off into a thunderstorm.

Ulm is a pilot for the Goodyear Co., and his demonstration of the aircraft — called "Inflatoplane" — was staged at a naval air station.

The aircraft is made of rubberised fabric.

It has a 23ft wingspread when inflated and weighs about 200lb.

Its 44-horsepower engine can pull it through the air at better than 60 m.p.h., and uses so little fuel it can stay aloft for eight hours.

Harp under control

WHAT will happen if a Harp rocket should get out of control when tests are carried out at Woomera late this year? An armed Meteor jet fighter will shoot it down.

The Harp experiments will be part of Australia's contribution to the International Geophysical Year program.

The word harp stands for high-altitude research project.

The authorities will take elaborate safety precautions in case a rocket should head the wrong way.

Radar will track the rocket in flight.

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Sydney and Melbourne

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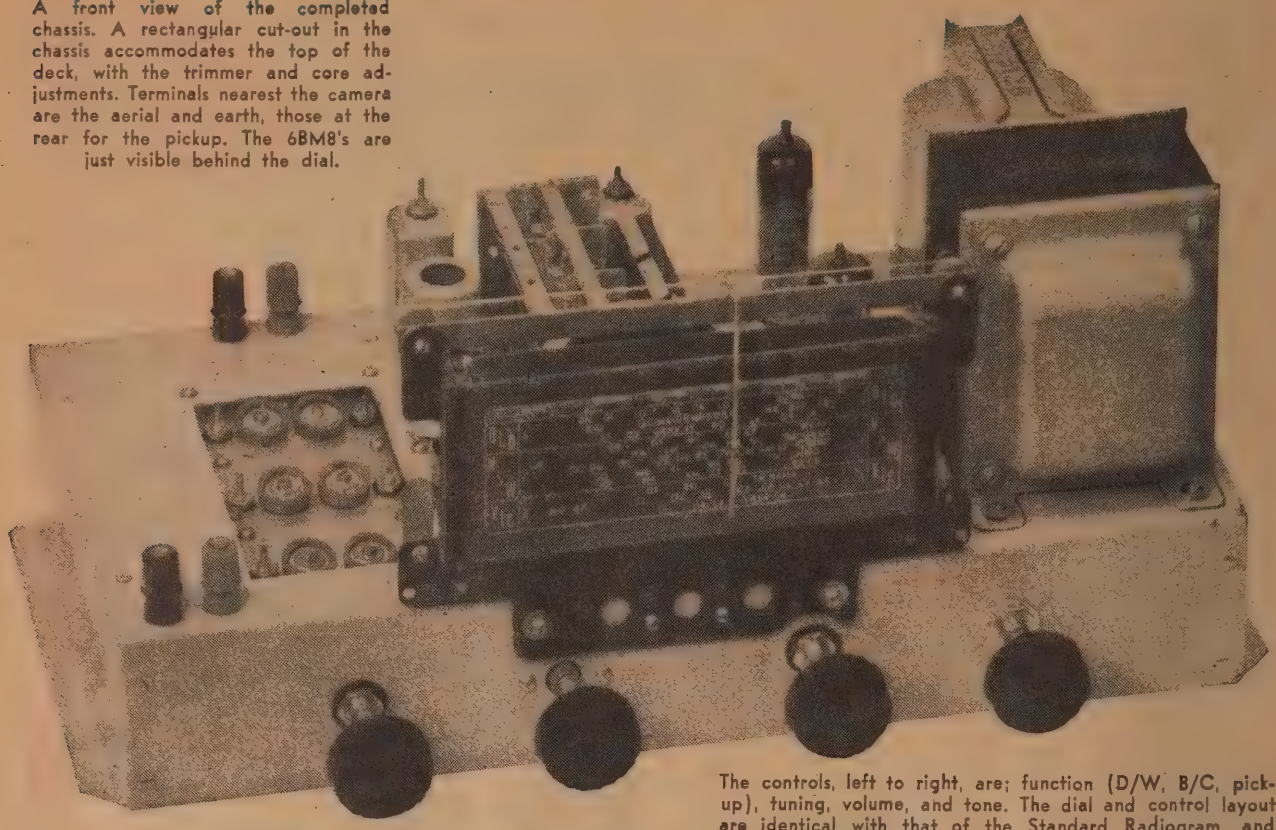


A front view of the completed chassis. A rectangular cut-out in the chassis accommodates the top of the deck, with the trimmer and core adjustments. Terminals nearest the camera are the aerial and earth, those at the rear for the pickup. The 6BM8's are just visible behind the dial.

The controls, left to right, are; function (D/W, B/C, pick-up), tuning, volume, and tone. The dial and control layout are identical with that of the Standard Radiogram, and fit the same cabinet.

The D/W Standard Radiogram

A logical development of our Standard Radiogram described in the May issue is this expanded, dual wave version which, in addition to the excellent performance with standard pickups, has extra gain and a short wave band particularly useful in country districts. It is designed to fit into the radiogram cabinet described in last month's issue.

by Philip Watson

ONCE upon a time, when radio was comparatively simple (remember?), one of our chief occupations was to describe various types of equipment designed for similar service in different ways.

When we were very young and inexperienced, we fondly imagined that there must be one best way of making a mantel set, an amplifier, or a radiogram which would render any other approach rather profitless and waste of time.

THEY ASKED FOR MORE

But it wasn't long before we learned that no matter how satisfactorily we imagined all the problems in a given design had been worked out, there would be plenty of people who wouldn't or couldn't agree with us, and who asked for more!

And so, in those uncomplicated days referred to in our first paragraph, we made the most of our opportunities to produce infinite variations on standard themes, much to the gratification of our insatiable readers.

But time has marched onward, and our scope has widened enormously in the last few years. If we are to cover adequately all the subjects there are to be covered, we must share out our space and energies equally amongst them.

So it was that, when we received a couple of letters recently from readers who were very sorrowful about our neglect of the "big" radiogram field, we could only agree that their sorrow was justified.

It is time we included a circuit with a full size front end, complete with RF stage, and a short wave band.

The RF stage is of doubtful value to people who live near broadcast stations, particularly city dwellers, for with the higher power used these days, signal strength is often an embarrassment rather than an advantage. Very rarely is such a stage needed to improved results at close quarters.

But in country areas it is a different story, as one of our correspondents pointed out. In many such cases the extra amplification is very much worth while, and may make all the difference between useable reception and perhaps none at all.

USE OF SHORT WAVES

The short wave band is tied up with much the same story. We don't know how many people ever use their short wave bands in the city, but there is no doubt that country people often depend on these bands to get programs.

This fact is recognised by the A.B.C., who beam special short wave programs to various parts of the country specifically for their use.

Having realised the case for such a receiver, and the desire to do something about it, the radiogram circuit and

cabinet described during the last two months seemed to be a good starting point.

If we could work out a chassis which would combine the good points of that circuit with the more elaborate tuning end, and which could be fitted to the same cabinet if required, we felt we would have done a very useful job.

The chassis part of it wasn't hard.. A few measurements revealed that it was quite easy to produce a suitable layout compact enough for our purpose, and yet suitable for almost any cabinet the builder had in mind.

THE FRONT END

Our next problem was how best to arrange the tuning end to get good results most economically.

Our first impulse was to work out a tuner essentially for the broadcast band, using a wave-change switch and extra short wave coils to be wired in if and when required.

We have a horrible feeling that someone will write to us and ask why we didn't do just that thing!

Our reason, briefly, was that we didn't see how much could be saved in pounds, shillings and pence by those most interested in the idea, and who would undoubtedly want the short wave band.

By adding up the cost of the broadcast coils, the switch, and the short wave coils, plus the extra difficulty of arranging for the necessary trimmers, six in all, we found that there would be little saved as against buying a complete coil assembly, in which all these things are provided for.

Moreover it would sit conveniently at the side of the tuning gang, and, by using a simple rectangular cut-out, all the adjustments to the coils would be in clear sight.

We did not consider using any of the elaborate, multi-band coil assemblies which have been produced in the past, as, apart from their size, they are more suited to luxury designs which we are not concerned with at the moment, and are very costly to buy.

MOST POPULAR METHOD

Enquiries around the radio stores brought out the fact that our proposed course was, in fact, the most favoured method of making a dual waver of this type among those who were building such receivers.

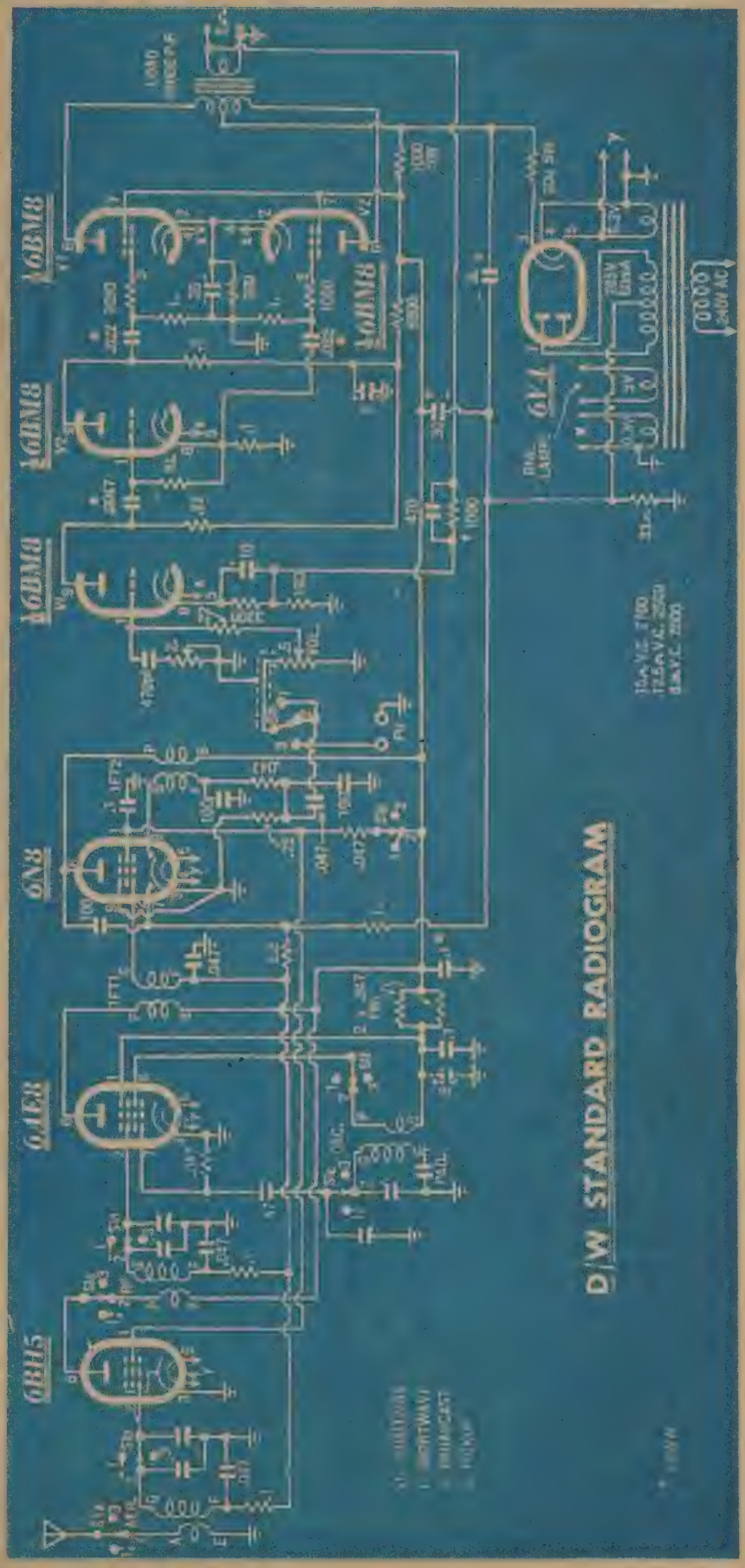
It seems that, when short wave reception is required, the RF stage coil bracket is far more popular than the type without such a stage, despite the extra cost.

Maybe the idea is that, having decided to spend a little more on a set, constructors feel that the extra expense of the larger bracket is well worth while.

Summing up, therefore, what have we finally been able to produce?

We have a radiogram circuit, with both broadcast and short waves, plus RF stage, obtained as cheaply in labour

CIRCUIT OF NEW D/W RADIOGRAM



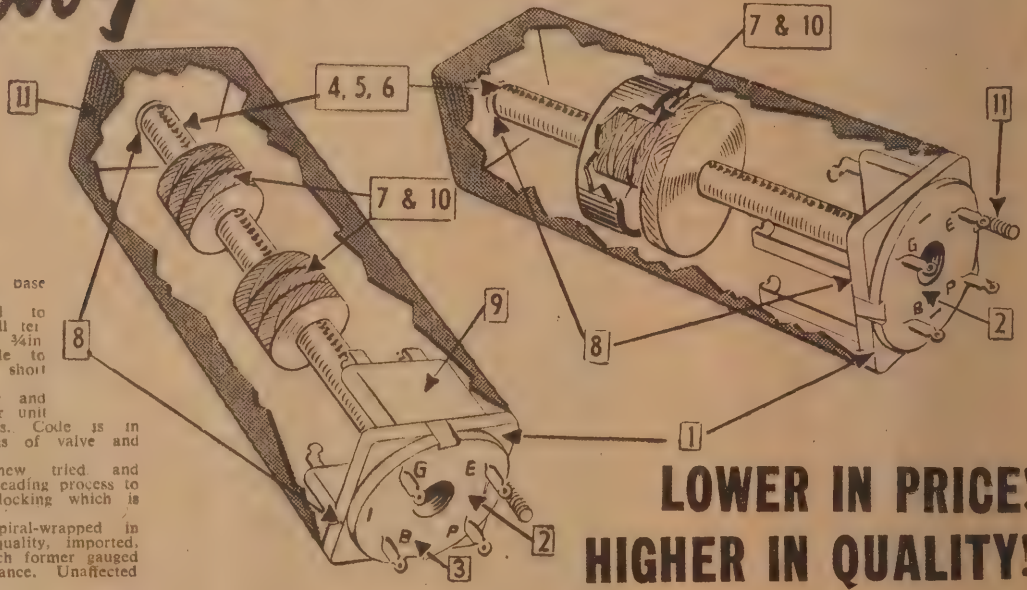
The audio section is identical with that of the Standard Radiogram, while the power supply is modified to provide back bias for the early stages. Much of the wiring shown is contained in the pre-fabricated deck, making construction relatively simple.

THE HIGH IQ* OF THE NEW

AEGIS

Mighty Midgets

Above: Charles van Scoy, Chief Aegis Design Engineer



LOOK AT THESE AEGIS HIGHLIGHTS:

1. New low-loss bakelite base (will not melt).
2. Base specially shaped to symmetrically position all terminals within standard ¾in 9-pin valve socket hole to eliminate accidental short circuit to chassis.
3. Connection code clearly and permanently visible after unit is mounted on chassis. Code is in alphabetical abbreviations of valve and circuit elements.
4. Former incorporates new tried and proven American-type threading process to ensure automatic core locking which is vibration-proof.
5. Former is specially spiral-wrapped in manufacture from best-quality, imported, resin bonded papers. Each former gauged and held to definite tolerance. Unaffected by extreme heat.
6. Highest quality carbonyl, 6 m.m., externally threaded adjustable cores incorp. hexagonal hollow centres — the world's greatest contribution to alignment technique. Core chipping and jamming is eliminated by use of solid nylon hexagonal alignment tool. Complete alignment possible from one end of any unit.
7. Litz. Multi-strand wire windings on all tuned circuit coils for greater Q-factors.
8. Former rigidly supported at each end Ensures vibration-free operation.
9. Supreme quality silvered-mica capacitors moulded in mica-filled phenolic resin to give increased insulation resistance, less moisture permeability and better power factor all of which mean a higher degree of electrical stability. Silver-plated brass terminals, specially shaped for ease of soldering into circuit. I.F. Transformers incorp. capacitors manufactured to within plus or minus 2½ pc of their rated value.
10. Inductances completely dehydrated and thoroughly impregnated with Q-kote "B" to guard against moisture penetration.
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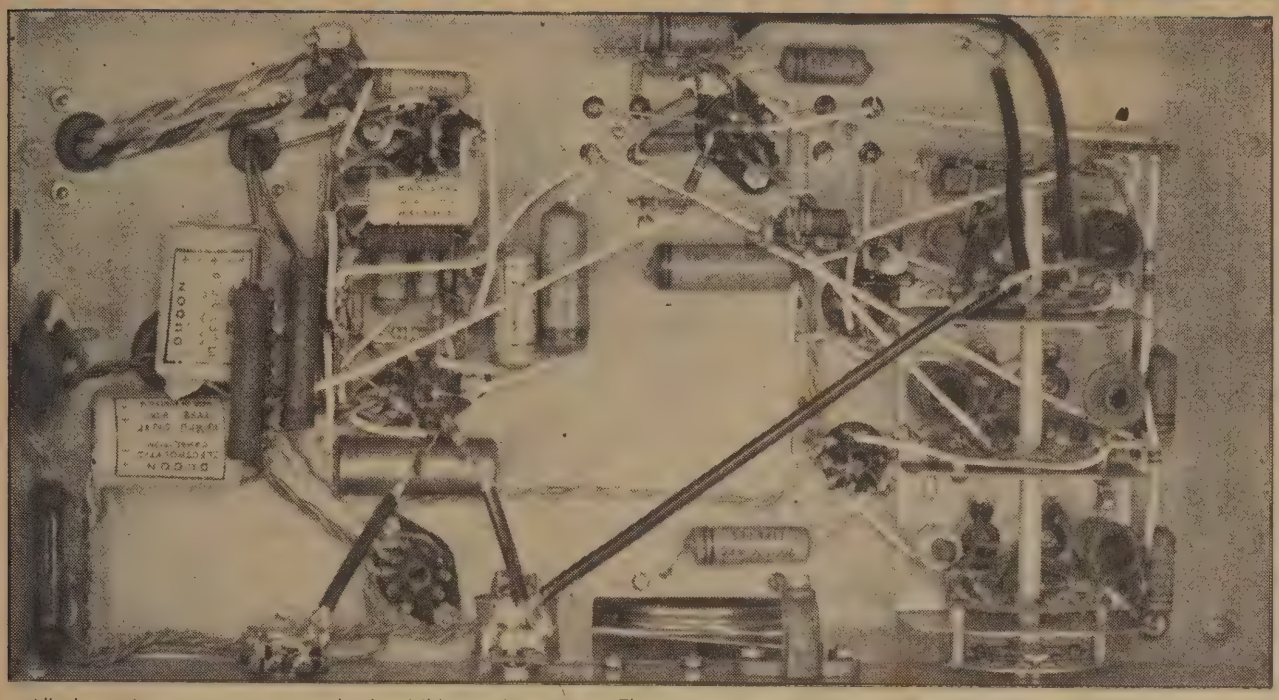
UNDERCHASSIS PICTURE HELPS WITH YOUR WIRING



All the major components are clearly visible in this picture. The dual wave deck is on the right with the 6BH5 (lower) and 6AE8 (upper) sockets immediately alongside it. The 6N8 is approx. top centre, the 6BM8's to the left, and the 6V4 beneath them. Note the 200 ohm dropping resistor at extreme bottom left.

and in money as seems possible at the present time.

We have an audio end, similar to that used in the original circuit, which is a particularly economical, neat, and effective method of obtaining good quality sound and adequate output. It is designed for use with standard, turnover crystal pick-ups of the type generally employed in the average man's radiogram.

If it is housed in our cabinet, with the special loud speaker damping unit described last month, it will sound much more impressive than commercial sets costing much more money to buy.

And finally it has great sensitivity on the broadcast band, adequate to tune in distant stations on a few feet of wire plus good short wave reception.

EASY TO BUILD

This all adds up to just the kind of thing our correspondents have been asking for, plus a simplicity of construction which makes it little harder to build than a standard broadcast receiver.

This is largely due to the prefabricated dual-wave deck which takes care of the entire coil assembly, along with the associated switching. As far as the "front end" is concerned it is then merely a matter of connecting a relatively few leads to H.T., A.V.C. tuning capacitor, etc.

In addition, we have modified the circuit to use back bias for the early stages. With three valves to be biased, this effects a worthwhile saving, three resistors and three capacitors being replaced by one resistor. Not only do we save the cost of these components, but we save the work of fitting them.

Finally, since we are no longer interested in wide range, the IF channel reverts to a standard arrangement, without any switching and additional circuitry.

Reference to the circuit will show that the audio section is identical with that of the Standard Radiogram, there being little point in altering this. However we did make some changes in the power supply, and these are worth noting.

As already mentioned, we fitted a back bias network for the RF and IF stages. This is simply a 33 ohm 1 Watt resistor between the power transformer centre tap and chassis. Note that BOTH the first and second electrolytic should be returned to the centre tap rather than chassis. The need to treat the second filter unit in this way appears to be a function of the simple resistance filter used in place of a choke.

The extra valve made it necessary to reconsider both the overall transformer

PARTS LIST

1 Chassis, 14 x 7 x 2¼ in.
1 USL/37 dial (D/W. MSP gang.)
1 MSP miniature 3 gang.
1 285V 80mA power transformer.
1 Output transformer. Prim. 10,000 ohms. Sec. Suit speaker.
1 D/W coil deck with RF stage DWR/5 or similar.
2 455 Kc miniature IF transformers.
2 Noval sockets with shield.
3 Noval sockets, plain.

RESISTORS

1 10 Meg. ½W
1 2.2 Meg. ½W
1 2 Meg. Pot.
3 1 Meg. ½W
1 .5 Meg. switch pot.
3 .22 Meg ½W
4 .1 Meg. ½W
3 .047 Meg. 1W
2 .047 ½W
1 .022 Meg. 1W
1 6800 ohm ½W
1 3300 ohm 1W
1 1000 ohm 5W
3 1000 ohm ½W
1 300 ohm 3W
1 200 ohm 5W
1 100 ohm ½W
1 33 ohm 1W

CAPACITORS

2 30 mfd 350V electrolytics
1 25 mfd 40V electrolytic
1 10 mfd 40V electrolytic
1 8 mfd 350V electrolytic
1 8 mfd 350V electrolytic (Optional. See text).
1 .1 mfd 400V paper
2 .1 mfd 400V paper
5 .047 mfd 200V paper
2 .022 mfd 400V paper
1 .0047 mfd 400V paper
1 470 pf mica or ceramic
3 100 pf mica or ceramic
1 47 pf mica or ceramic
1 33pf mica or ceramic

VALVES

1 6BH5, 1 6AE8, 1 6N8, 2 6BM8's, 1 6V4

SUNDRIES

4 knobs, 4 terminals (2 red, 2 black), 3 7 lug strips, 3 5 lug strips, 1 4 lug strip, 2 3 lug strips, nuts and bolts, solder lugs, shielded hook-up wire, plain hook-up wire, 2 dial lamps, 3 core flex, 2 core flex, 3 pin power plug.

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Roblan 2 gang	29/-
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Roblan 3 gang with Vernier drive	41/6
Roblan F.M. 2 gang	36/-
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M.S.P. 3 gang standard	39/-
M.S.P. 3 gang miniature	37/6
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8H	45/6
8M	58/1
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120	107/6
120 De-Luxe	117/6
120X	£10/2/7
12UX Hi-Fi	£28/19/5
Speaker Silk	17/6 yd

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Goldring L56 arm only	£7/10/-
Ronette	£7/9/1
Acos HGP38	£5/15/-
Acos HGP40	£9/15/-
Acos GP50	£4/19/6
Acos GP60	£6/16/-
Acos GP10	£3/12/6

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EFCO USL/37	38/6
EFCO USL/46	56/6
EFCO USL/44	42/3
EFCO USL/52	74/2

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rating and the distribution of load on the filament windings. Adding up the total HT drain showed that it was likely to be in vicinity of 90 mA under conditions of no signal or weak signals, thereby suggesting that the original 80 mA transformer could be overrated in some circumstances.

On the other hand, a 100 mA transformer is not only more costly but also more bulky, making it difficult to accommodate on the size chassis to which we were limited.

We overcame the problem by assessing the total wattage consumed by the receiver and comparing it with the maximum wattage rating of the transformer, as indicated by the rating of all windings. This showed that the transformer, as a whole, would be operating considerably below its maximum rating, even though one winding was running some 10 per cent. high.

TRANSFORMER RATINGS

We reasoned that the individual winding was not likely to be harmed by this, provided the transformer was still running below its maximum temperature rating, but we took the matter up with one of the transformer manufacturers just to be on the safe side. When they gave the scheme their blessing, we reasoned that it was good enough.

The filament distribution was not so difficult. By supplying the two 6BM8's from one winding, and all other valves from the other winding, we loaded each to about 1.5 amps. The dial lamps may be taken from either winding, shared by both, or run from the five volt winding. We recommend the latter arrangement, since the lamps will have much longer life on this reduced voltage.

We choose the 6BH5 for the RF stage, this being a miniature type having a moderate amplification factor (by modern standards). It is therefore less likely to cause embarrassment to the home builder, as might a higher gain valve with its tendency to oscillate if the layout is not exactly right. At the same time there is plenty of sensitivity, both on the broadcast and short-wave bands. In fact, it is difficult to imagine that more sensitivity could be used, anything not audible on a set of this type being well down in the noise level anyway.

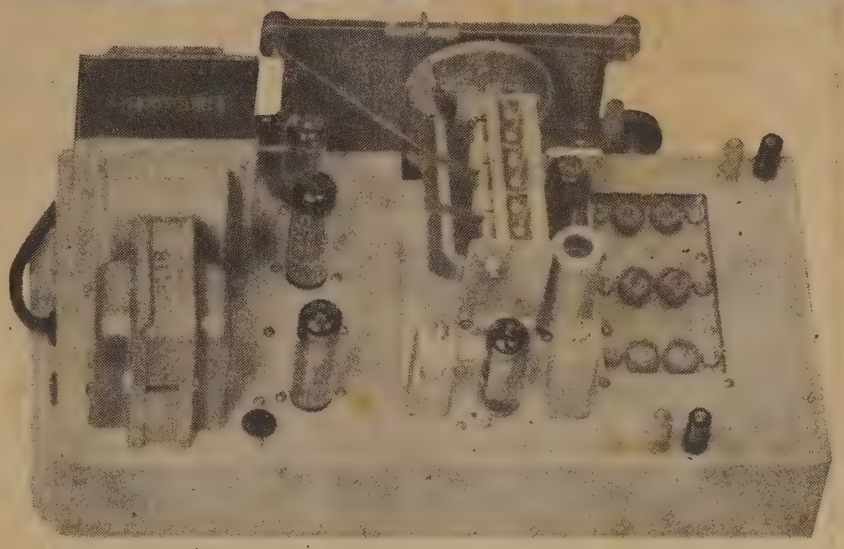
It will be noticed that an extra 8 mfd electrolytic is shown (dotted) in parallel with the .1 mfd paper version used to by-pass the supply to the oscillator plate and mixer screen. Its purpose is to stabilise this voltage against the possibility of motor-boating on the short wave band. It was not necessary in the original — which was remarkably stable in all respects — but is included in case individual sets give trouble.

CHASSIS SIZE

The chassis is both longer and wider by one inch than its predecessor, but can still be accommodated in the Standard Radiogram cabinet. The only precaution is to see that no terminals or outlet sockets are mounted on the rear or side of the chassis. However, the power cable enters one end of the chassis without difficulty.

The depth of the chassis remains as before, as does the position of the control and dial mounting holes, thus ensuring that they will match the layout prescribed for the cabinet. However, it would be wise to leave the cutting of the cabinet holes etc., until the chassis is complete.

REAR VIEW OF NEW RADIOGRAM



Here the trimmer and core adjustments of the D/W deck are seen on the right. The 6N8 is behind the gang with the IF's and the 6BM8's to the left. The 6V4 is near the front of the chassis.

The deck we chose was the DWR/5 and our chassis layout and design is based on this unit. This does not mean that other types, having the same general characteristics, cannot be used, but it would be necessary to check the physical characteristics carefully first.

Also, whatever deck you choose, we suggest that it cover the six to 18 Mc (16 to 50 metres) rather than the older seven to 23 Mc (13 to 42 metres) band. This latter misses out on several of the local short-wave bands which form a part of the complete short-wave system. If they are not available, half the usefulness of the short-wave section is lost.

DECK MOUNTING

The deck is mounted beneath a rectangular cut-out in the chassis, this giving access to the trimmers and coil slugs which are mounted on top of the deck. It is supported at the front by the switch mounting and at the rear by two bolts through the chassis. In our case it was necessary to provide a spacer, in the form of an extra nut, to balance the position of the front mounting hole.

The coil switch is a three-position one, two positions being used for broadcast and short-wave, and the third being spare. There is also a spare set of contacts on each switch section, and these facilities are used to accommodate the pickup circuit.

The spare contacts on the oscillator section are used to switch the volume control to either the detector or pickup terminals as required, the pickup terminals being mounted at the rear (top) of the chassis behind the deck.

The spare contacts on the RF (centre) section are used to open the screen supply to both the RF and IF valves when the pickup is switched into circuit. This is essential to prevent "play through" of the radio program, due to stray capacitance pickup, etc.

A good idea of the layout can be obtained from the photographs and we suggest you study these while reading the text. The RF and converter valves are located immediately alongside the dual wave deck, opposite the first and second shield partitions respectively.

The RF valve is so orientated that pin 9 is closest to the shield, while the 6AE8 socket is rotated slightly, bringing pin 8 into this position. The 6N8 socket has the pin gap closest to the rear of the chassis, and the two 6BM8 sockets face in the general direction of the coil deck. The 6V4 faces the front of the chassis.

The gang leads are brought through the chassis close to their respective terminal points, thus keeping them short beneath the chassis where their position is most critical. It is a good idea to solder a short length of hook-up wire to each lug on the underside of the gang before it is mounted, since this is not so easy to do afterwards.

A five-tag terminal strip near the 6AE8 socket supports one end of the 47 pf oscillator grid coupling capacitor, the two .047 meg. oscillator plate dropping resistors, a HT anchor point, and an anchor point for the RF and IF screen dropping resistor. This latter is connected to the common contact on the RF wave change switch, the two appropriate fixed contacts (B/C and SW) being bridged and wired to the HT lug on the far side of the deck.

Another five-tag terminal strip is mounted near the 6N8 socket. This supports the .22 meg. diode load resistor, the .047 mfd coupling capacitor, one end of the .047 meg. decoupling resistor, and one end of the 100 pf mica by-pass.

AVC COMPONENTS

On the opposite side of the second IF transformer a two-tag strip serves as an anchor point for the 1 meg. AVC load resistor and to which is run a lead from the back bias resistor.

The AVC components associated with the RF and converter stages are mounted on or between terminal lugs already provided on the far side of the dual

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SL-1 for standard 78 r.p.m. records.
SL-2 for microgroove 33⅓/45 r.p.m. records. Use with Acos G.P.61 cartridges.

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wave deck. One extra terminal strip is mounted at the rear corner of the deck to serve as an anchor point for one of the .1 meg. resistors.

As described in the May issue, the audio section is constructed around a five and a seven-terminal tag strip running between the two 6BM8 sockets, the larger one being closer to that end of the chassis. Another seven-terminal strip nearby supports the 1000-ohm filter resistor, the back bias resistor, and some of the electrolytic leads.

The power transformer primary leads are terminated on a four-terminal strip the extra terminal being required to accommodate the lead to the potentiometer switch. The 200 ohm dropping resistor is mounted on a doctored seven terminal strip in the front corner of the chassis. (It is important to keep this resistor away from the volume control and audio leads.) It is mounted by means of one of the power-transformer mounting bolts.

Shielded cable (PT9M in our case) is used for the audio connections, a lead from the detector running along the back of the chassis to the switch section of the dual-wave bracket, while another lead from the common contact runs diagonally across the chassis to the volume control.

WIRING PRECAUTIONS

Around the volume control itself it is necessary to take a few simple precautions to avoid hum pick-up. The 240V A.C. lead running to the volume control switch contacts must be twisted and tucked well away from the audio leads, up against the front fold of the chassis.

The same applies to the lead from the cathode of the rectifier to the 200 ohm limiting resistor. This lead is particularly important, since it is carrying the unfiltered output from the rectifier and can set up quite a substantial field. The same applies to the 200 ohm resistor, and is the reason for its placement in the far corner of the chassis.

The leads from both the volume and tone controls to the input grid terminal must be shielded and should be run direct. The 400 pf. and the .22 meg. resistor should be mounted as close as possible to the grid pin.

Another probable source of hum—not peculiar to this set-up—involves the earthing of the gramo-motor frame. This is normally connected to the outer braid of the pickup cable, thus forming part of the input signal path. If, in addition, we earth the motor in the normal way through the third wire of the power cable, there is a real risk of creating a hum-inducing earth loop. This is especially so if the motor is operated from a separate lead to the main power point.

EARTHING CIRCUIT

If we depend entirely on the earthy side of the pickup circuit to earth the motor frame the possibility of an earth loop will be eliminated, but we create a potentially dangerous situation inasmuch as the motor has no protective earth if ever the pickup is temporarily disconnected from the chassis. In the event of a motor breakdown the resultant live frame would be very dangerous by reason of the adjacent well-earthed chassis.

The best solution appears to be that of taking the power lead to the motor from the power transformer input terminals, using a conventional three-core cable. In a set of this kind where the audio gain is only moderate, it will probably be sufficient to earth this lead to any convenient point on the receiver chassis. However, if hum due to this source is still in evidence, it should be earthed directly to the pickup input earth terminal.

Provided these few simple precautions are taken the output should have an extremely low hum content, in spite of the simple filter network.

The actual construction should not present any difficulty, particularly if a correctly punched chassis is used. This is really half the battle and we suggest that one of the ready-made variety be obtained along with all the other parts. Alternatively, you can make your own if you have the facilities, and blueprints will be available through the query service in the normal way.

Either way, the fact that all the holes are punched in the right place removes most of the guesswork, and it is then mainly a matter of commonsense to ensure that the various grid and plate leads are kept short and well clear of each other.

One small point which can be easily overlooked concerns the two A.V.C. resistors which connect to the 6N8 diode. These should be mounted as close to this pin as possible, this end of each being "hot," while the other end is "cold" and not particularly critical.

MORE ABOUT OUR T.V. RECEIVER

ELSEWHERE in this issue, we give you the third and final article describing the basic 17-inch Television Receiver. Already, however, we are receiving enthusiastic reports from readers who have completed the set and are getting excellent results from it.

Next month we will tell you how to add Gated AGC, enlarge the sound channel and, if time permits, add a cascode RF amplifier to your home-built tuner. We may be able also to give additional helpful information about aerial systems, installation and alignment.

When everything is completed it will probably be found that the set works immediately, since both the I.F. transformers and the coil deck should be roughly aligned as you receive them. However, it will be essential to align the set correctly if the full benefit of the design is to be realised, and a few points on this subject may be helpful.

Although it is possible for experienced workers to produce moderately accurate alignment using only the signals from broadcast stations, this arrangement, at best, can be considered only as an emergency measure. If the set is to give really top performance we must assume that a signal generator is available.

Almost equally important is an output meter. This facility is normally found on most multimeters, and the signal is usually measured across the primary of the output transformer, or between one output valve plate and chassis. Set it initially to the highest voltage range, reducing it only when the operating level has been established and is not likely to change suddenly. Failure to observe this may result is an overloaded meter.

The first section to be adjusted is the I.F. channel. Set the generator to 455 Kc, with modulation on and adjusted to about 30 pc. Output from the generator is fed to the signal grid of the 6AE8 converter (pin 2) and it may be necessary to refer to the generator manufacturer's instructions to determine whether the outlet terminals may be connected directly, or whether any additional coupling device is necessary.

V/C SETTING

Ideally the receiver volume control should be advanced to maximum, and the input from the generator kept at a minimum throughout the entire alignment procedure. The reason behind this is to keep the input signal below the level where it would normally bring the A.V.C. circuit into action. The A.V.C., by attempting to compensate for changes in signal strength, tends to mask the improvements in sensitivity due to adjustment.

In practice it may be difficult to operate the set—particularly one with an R.F. stage—"flat out" without running into interference from strong local stations. During the I.F. alignment short the aerial and earth terminals and set the tuning gang to the wide open position.

Starting with the second I.F., adjust each core for maximum signal, reducing the output from the generator as the output from the set rises. Some cores will show a peak in two position; well in and well out. The outermost peak should be selected. Go over the entire channel several times until you are satisfied that all adjustments are optimum. Then seal each one securely.

Transfer the generator leads to the aerial and earth terminals (removing the short) and set the generator to 600 Kc. Set the receiver dial to 600 Kc and adjust the B/C oscillator slug until the signal is received at maximum strength. Follow up with the R.F and aerial slugs.

(Once again, trouble may be experienced in operating the set at full gain without interference. In the absence of a screened room the amateur can only compromise on the control setting, keeping it as high as possible at all times.)

HF END

Now set the generator and receiver to 1400 Kc and adjust the oscillator, R.F., and aerial trimmers in that order, not forgetting to reduce the output from the generator as the gain comes up. It may be necessary to repeat both the foregoing operations for best results. Then seal all adjustments securely.

Finally, comes the short wave band. The procedure here is similar to the broadcast band, the slugs being adjusted at the low frequency end at about 7 Mc (43M) and the trimmers at the high frequency end around 16 Mc (19 M). However, adjustment will be more critical and it is sometimes helpful to rock the dial gently across the signal as adjustments are made.

A further precaution is to avoid being mislead by the double spot. If the signal is strong enough it will be found at two spots on the dial. The signal having the higher of the two frequencies is the correct one.

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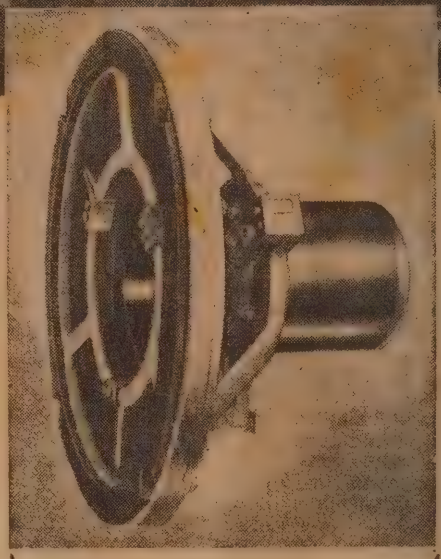

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Radio Transmission—How It Works

☆ ☆ ☆

Oscillator stage and the tuned circuit. Frequency and quartz crystals. RF power amplifiers. The transmitting aerial. Morse code. The nature of sound. Modulation amplitude and frequency. A complete transmitting station.

☆ ☆ ☆

Having taken in a good deal about the fundamentals of radio components and circuitry, it now remains to bring these together to form a mental picture of how speech and music can be carried by radio waves to distant points. Hence the title of this article.

RADIO transmission is an extremely involved subject and one on which many specialised textbooks have been written. Quite deliberately, we're going to bypass a lot of the difficulties and detail in an effort to give you a mental picture of the processes by which radio transmission and reception are achieved.

With this general background, one is in a better position to learn the practical lessons which are to be had from building the first small radio set—no matter how modest it may be.

Though there may still be an element of mystery about it all, this preliminary study of principles will prevent the radio set from being a completely meaningless jumble of wires. Let us learn something, then, of the transmitter.

The heart of every modern transmitter is the so-called OSCILLATOR stage, which generates the initial radio frequency signal.

In our chapter on electrical circuits, we learned of the oscillatory tendencies of a tuned circuit comprising an inductance and capacitance in parallel; how that an initial impulse causes a train of damped waves to be generated, of substantially constant frequency but diminishing amplitude.

A tuned circuit thus exhibits a "flywheel" effect in an electrical sense, transforming an initial single impulse into a more sustained electrical phenomenon.

In this respect, there is a simple mechanical analogy to a flywheel, and the analogy can be taken a step further. The energy evident in a revolving flywheel is of a limited and temporary nature, so that the flywheel is of little use as a source of power. It comes to rest as the energy is absorbed by frictional losses and any superimposed mechanical leading.

But a flywheel becomes invaluable if it is coupled to a driving piston. The periodic thrust supplied by the piston is changed to a smooth rotary motion by the action of a crank and flywheel.

So it is with a tuned circuit. A single damped oscillation, or even a series of such oscillations, are of limited use for radio work. But inventors have found means of coupling a radio valve to a tuned circuit to maintain the latter in a constant state of oscillation.

LIKE FLYWHEEL

Just as the piston delivers a mechanical impulse to a flywheel under the guidance of a mechanical valve system, so does an electron tube—or valve in the electrical sense—deliver electrical impulses to a tuned circuit.

The amplitude of the wave train, instead of diminishing, is kept constant and continues for just as long as the circuit is left in operation. The effect is illustrated in figure 1.

The complete combination of tuned circuit, valve and associated components is referred to as an oscillator stage. In actual fact, there are numerous circuit arrangements, all of which achieve the desired result, but some more conveniently than others.

An elementary type of oscillator, which will serve to illustrate the basic principle, is illustrated in figure 2. Here, a tuned circuit comprisng L1 and C1 are coupled to the grid of a valve through capacitor C2. Another coil, L2, is connected in series with the plate supply and coupled inductively to L1.

When the circuit is switched on, there is an initial and increasing movement of electrons from cathode to plate, through the coil L2, to the high tension supply source. The flow of current through L2 creates an electromagnetic field, which naturally influences and induces a voltage in L1.

The relationship is such that the grid receives a slight positive impulse as a result, and this tends to accelerate the rise in plate current. This, in turn, accentuates the initial effect in L2.

The grid is driven positive to an extent where it attracts a big proportion of the electron current, so that the plate current can no longer maintain its rising tendency.

The magnetic field around L2, there-

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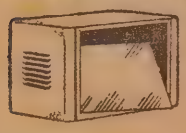

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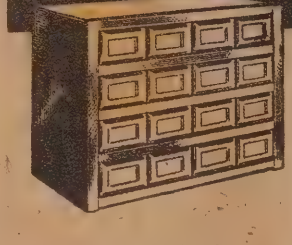

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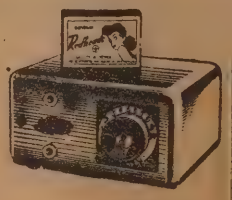

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fore, begins to collapse, inducing a reverse change in the field around L1, so that the grid now begins to become increasingly negative. The process accelerates until it is negative enough to cut off the plate current.

Once the decreasing effect in plate current ceases, the magnetic fields around L1 and L2 begin to collapse and reverse, and the whole process is repeated again and again. The tuned circuit L1, C1 is maintained in a constant state of oscillation until such times that the supply to the valve is interrupted. The components C2 and R1 have an important bearing on the smooth functioning of the circuit.

All oscillator circuits operate in much the same way, but the circuit details vary in the method of feeding the energy from the plate back to grid.

The frequency of the alternating voltage generated is determined mainly by the constants in the tuned circuits — that is by L1, C1. In practice, it is likely to be affected slightly by humidity and temperature, by physical variations in the components, and by variations in the supply voltages to the oscillator valve.

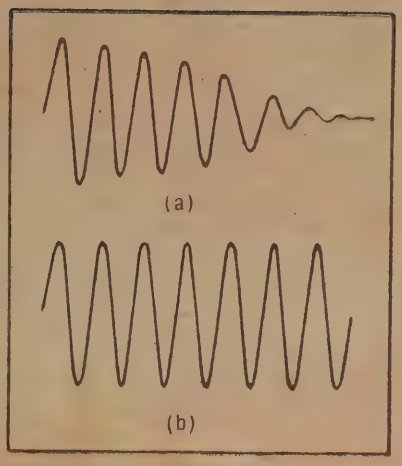

Figure 1: Illustrating a damped train (a) and a sustained wave train (b), as produced by a valve oscillator.

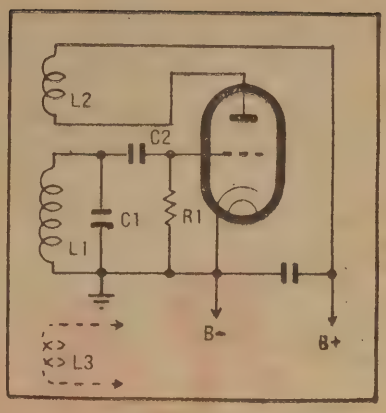

Figure 2: A simple oscillator circuit. Energy is fed back from the plate coil L2 to the grid coil L1. Output can be taken to external circuit through the coupling coil L3.

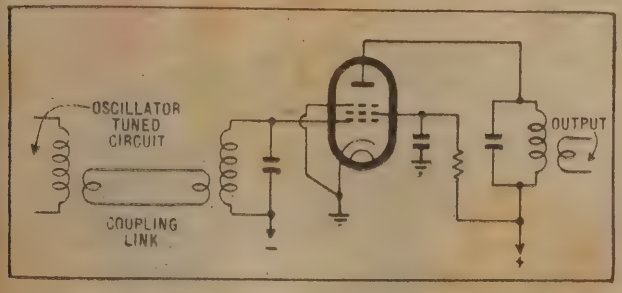

Figure 3: The basic circuit arrangement for an RF power amplifier using, in this case, a pentode valve.

Appreciable frequency variation is most undesirable — and often illegal — in even modest transmitting equipment, so that every effort is made to avoid it. Supply voltages to the oscillator valve are regulated electronically and, in many cases, the whole oscillator stage is contained in a temperature-controlled oven, to minimise the effects of atmospheric changes.

The problem of maintaining frequency stability has been simplified by a remarkable device and phenomena — namely the PIEZO-ELECTRIC effect exhibited by certain crystals.

CRYSTAL OSCILLATES

It has been found that, when slabs of certain crystals are subjected to mechanical stress, a small voltage appears between opposite faces, and, inversely, when a voltage is applied to those faces, the slab of crystal becomes very slightly distorted physically.

But, what is more important, a crystal will show surprising activity — a marked oscillatory effect — if it is excited electrically at a particular frequency determined by the mechanical properties and dimensions of the crystal.

In actual fact, it behaves electrically in a similar manner to a very efficient tuned circuit. Thus, when a crystal is connected in appropriate fashion into an oscillator circuit, the valve will generate oscillations exactly as if there were actually an efficient tuned circuit coupled to its grid.

Specialists simply grind the faces of the crystal until the natural frequency of oscillation is exactly as desired, and the crystal will oscillate electrically on this frequency with less tendency to wander than an ordinary tuned circuit. If it is installed in a temperature controlled oven, so much the better.

Hence the term CRYSTAL CONTROLLED transmitter.

Our normal broadcast band extends from 550 to 1600 kilocycles per second, so that crystal oscillators at the various broadcast stations are adjusted to generate the exact signal frequency on which the station is allowed and required to operate.

Various other services—shipping, news, telegraph, etc.—utilise stations at frequencies higher than 1600 Kc/s, and there are also SHORT-WAVE broadcast stations operating on frequencies up to about 30 megacycles per second. Beyond that again are frequencies utilised for FREQUENCY MODULATED transmissions, TELEVISION and RADAR.

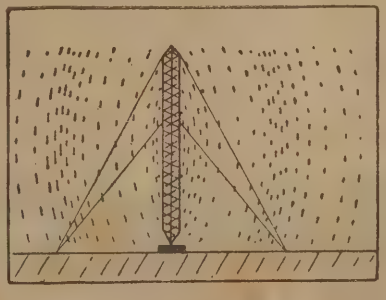

Figure 4. A transmitting aerial can be likened to an enlarged tuned circuit surrounded, in operation, by magnetic and electrostatic fields. Because these fields move out into space, radio energy is "broadcast".

Every one of these transmitters has its own oscillator stage—generally crystal controlled.

The power supplied to the tuned circuit (figure 2) by the oscillator valve is more than enough to maintain the oscillation. In fact, power can be led off from the tuned circuit to an external circuit.

The usual method of coupling the oscillator to an external circuit is to mount a small coupling coil (shown as L3 in figure 2), so that it is inductively coupled to the main tuned circuit. The signal voltage induced in L3 can be applied, if necessary, direct to an aerial/earth system for purposes of transmission.

POWER AMPLIFIER

But except in the most elementary transmitting equipment, the aerial is never coupled direct to the oscillator stage. For one thing, it is difficult to obtain the necessary power output from the oscillator, without compromising the requirements for frequency stability.

The inductive and capacitive properties of the aerial system, when intimately coupled to the oscillator tuned circuits, affect their natural resonant frequency and therefore the frequency of the signal generated.

Other undesirable effects accrue from the necessary requirement of imparting intelligence to the RF signal—something which yet has to be discussed.

Principally because of these considerations, it is usual practice to add one or more radio frequency power amplifier stages after the oscillator. These build up the power of the signal to the necessary figure, and isolate the oscillator from the effects previously mentioned.

The oscillator itself is designed to generate only a comparatively small initial signal voltage and power, but very accurate and constant with respect to frequency.

A transmitter may use one or more amplifier stages after the oscillator, and they are usually coupled one to the other and to the oscillator by a series of resonant circuits (See figure 3).

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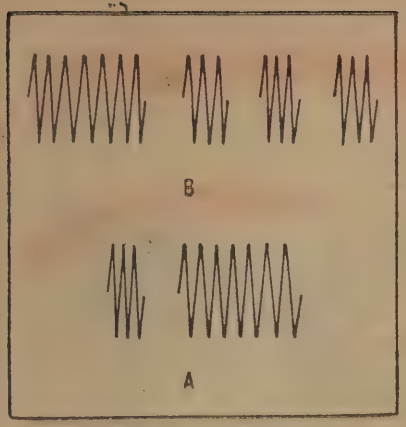

Figure 5. The most elementary means of putting "intelligence" on a radio carrier is by means of the Morse code. A different pattern of short bursts (dots) and long bursts (dashes) of radiation indicate letters, figures, &c.

It is unnecessary, at this stage, to dwell further on the subject of RF power amplifiers, save to mention that the last one feeds the high frequency energy developed in its plate circuit into an aerial/earth system for purposes of transmission.

As a general rule, the radio frequency power absorbed by a transmitting aerial is approximately one half the DC power in watts (volts x amps) fed to the plate circuit of the final RF power amplifier.

It may be the cause of some wonder just how an aerial system can absorb and radiate power into space. Actually it is a very involved subject, but the following will give some form of mental picture of how it comes about.

It is necessary to realise that transmitting aerial is not just a length of wire suspended more or less at random, as generally happens with a receiving aerial. Nor is it just a vertical tower put up to impress the passers-by.

Whether it takes the form of a suspended wire or a vertical steel tower, it possesses capacitive and inductive properties and these are carefully considered at the time of erection.

HUGE TUNED CIRCUIT

Having such properties, it may be likened to a gigantic tuned circuit, with definite resonant effects. And, furthermore, the length of the aerial or tower bears a definite relationship to the wavelength of the signal to be transmitted.

Knowing the frequency and wavelength on which the broadcasting station is to operate, the design engineers calculate the length of aerial which will give approximately the required characteristics, and stipulate the way in which the high frequency energy must be fed into it. Any adjustments necessary thereafter are effected with the aid of auxiliary tuning and coupling circuits.

When a signal voltage is fed to a conventional tuned circuit, then energy builds up an alternating magnetic field around the coil and corresponding electrostatic charges across the condenser. Energy is drawn from the source each time the alternating magnetic field is built up, but returned to the source as the magnetic field begins to collapse an instant later.

Only a small proportion of the energy is lost, depending on the characteristics and efficiency of the tuned circuit.

But let us imagine that the inductance is enlarged in physical dimensions, so that the magnetic lines of force surrounding it spread over a greater area. As the field collapses each time, fewer of the magnetic lines will cut the coil, and therefore less energy will be returned to the source. In other words, the tuned circuit will absorb and dissipate more of the energy fed into it.

Now consider the extreme case where the inductance is amended until it becomes a single length of aerial wire or a vertical steel tower. It will have inductive and capacitive properties and, in addition, a definite relationship to the wavelength of the signal to be transmitted.

When high frequency energy is fed to it, lines of force are set up around it,

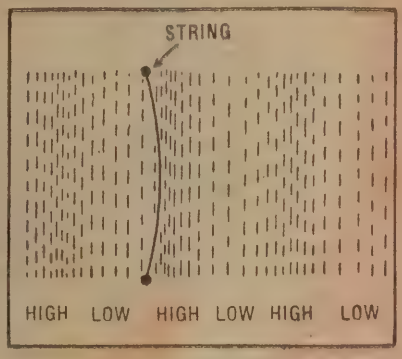

Figure 6. A string or reed, in vibrating, causes pressure waves in the surrounding air, which we interpret as sound. Vibration of the supporting framework in sympathy with the string increases intensity of the sound.

extending necessarily over a large area. But on the portion of the input cycle where the magnetic field collapses, the energy does not all return to the source; instead, the lines of force move outward into space.

Thus, the high frequency energy developed in the plate circuit of the final amplifier is fed into the aerial system and radiated by it as an electrical wave. Just as the ripples spread outwards from a centre of disturbance over the surface of a still pond, so do the electrical undulations emanate into space from the transmitting aerial. The distance they cover before fading into apparent nothingness depends on the original output power and the frequency of transmission.

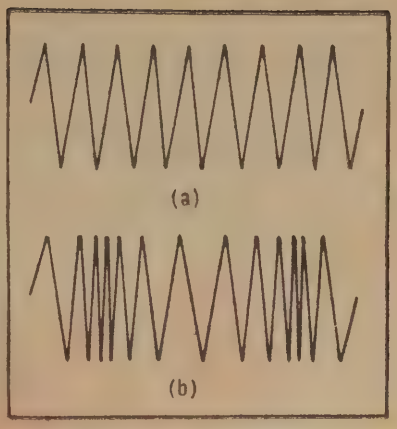

Figure 8. In frequency modulation, the effect of the audio signal is to produce a variation in the frequency of the carrier signal, the amplitude remains constant.

Our broadcast-band stations are intended mainly for coverage within a radius of a few hundred miles. But signals radiated at higher frequencies —the short waves—skip half-way around the world with ease.

Thus far, we have envisaged only the radiation of high frequency radio energy without any thought of transmitting intelligence by it. Obviously a radio wave transmitted into space without such a provision is as meaningless and futile as a blank sheet of paper mailed through the post.

MORSE CODE

The next question is that of imparting an intelligent message to the radiated energy so that it can be picked up at remote points and the message understood.

One very simple approach to this problem is offered by use of the so-called MORSE CODE. At the transmitter, an operator is provided with a morse KEY, which is so connected to the circuits of the transmitter that energy is radiated only when the key is depressed.

With the key in the normal open position, no energy is radiated.

If now the operator wishes to send the letter "A," he presses the key to send a brief DOT, followed immediately by a longer DASH. The letter "B," on the other hand, is represented by a dash and three dots, and "C" by the combination dash, dot, dash, dot.

There are standard code signals for

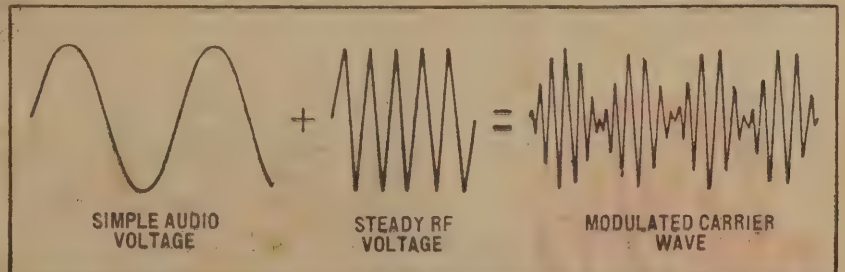

Figure 7. Illustrating the basic concept of modulation. An audio signal, not capable of being transmitted directly, is superimposed on a radio "carrier", to produce the result as shown.

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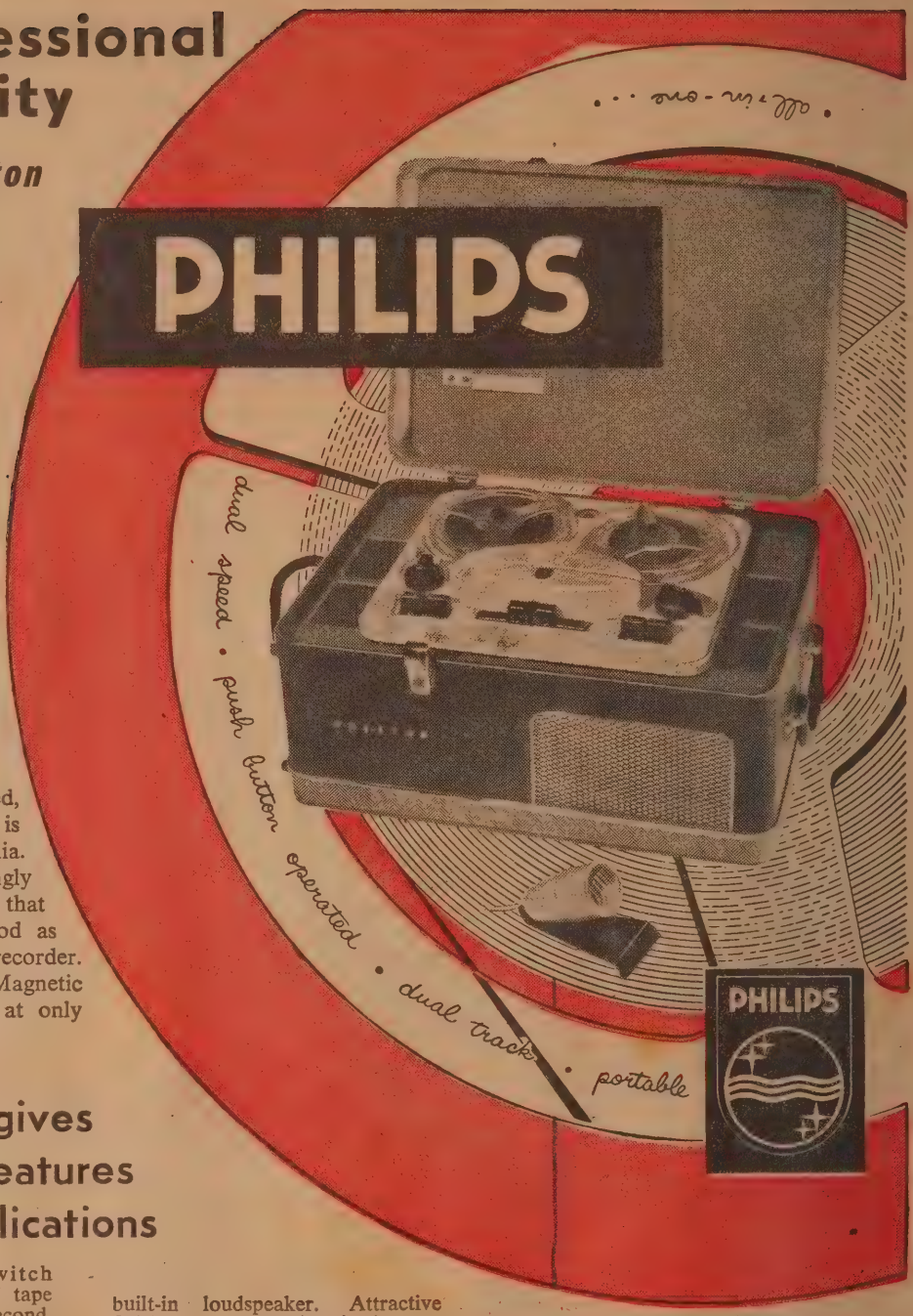

This magnificent, dual-speed, portable Tape Recorder is now available in Australia. Here at last is an amazingly low-priced Tape Recorder that offers reproduction as good as an expensive professional recorder. The Philips Push-Button Magnetic Tape Recorder is priced at only £149/5/- (including tax).

The EL 3511 gives **ALL** these Features for **ALL** Applications

TWO SPEEDS: Speed switch enables rapid adjustment of tape velocity to 1⅞" or 3¾" per second.

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ALL-IN-ONE DESIGN: One case, complete with microphone and built-in loudspeaker. Attractive finish with washable plastic case cover and removable lid.

HIGH-FIDELITY REPRODUCTION: The properties of microphone, amplifier, loudspeaker and recording/playback head ensure excellent quality. Here is a recorder that provides good sound reproduction even at the low speed of 3¾".
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MIXING FACILITIES: Two programmes may be mixed in the desired intensity ratio through the extension sockets and the Philips high-quality dynamic microphone, type 1115.

FAST FORWARD AND REWINDING: This can be effected within two minutes and accidental erasing is impossible.

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all the letters of the alphabet, for the numerals, punctuation marks, and also a series of abbreviations for certain frequently-used expressions.

Operators become extremely proficient in sending and reading morse code messages, typical operating speeds varying between 15 and about 25 words per minute.

For substantially higher speeds, messages are transferred by a special machine to a tape, then transmitted and received by tape at a speed far higher than possible by direct human agency.

In fact, the whole job of coding and decoding on tape can be done automatically on machines which are operated something like a typewriter.

LIMITED USE

The morse code, and similar code systems, are widely used in communication circuits, the circuits offering a certain amount of secrecy and occupying a minimum space in the rather crowded frequency spectrum. Furthermore, code signals can often be followed under atmospheric conditions which would rule out other forms of transmission.

But code transmissions are obviously not an attractive proposition to the average listener, whose natural desire is to hear normal speech and music emanating from the receiver.

To make this possible, the high frequency CARRIER wave is MODULATED with signal voltages representing voice and music, and these become audible again as such at the receiving end.

Before the process of modulation can be understood it is first necessary to know something of the nature of sound. A simple approach is to visualise a vibrating string, as on a violin, guitar, piano etc.

Depending on its mass, length and tension, such a string has a certain natural period of vibration. Exactly the same is true of the reeds in a harmonium or accordeon, or the column of air in organ pipes, when suitably excited.

A string or reed in a state of rapid vibration disturbs the surrounding air and sets up pressure waves, which radiate outward at a uniform speed of about 1100 feet per second.

ELECTRICAL DISTURBANCE

Just as a falling stone produces a series of ever-widening ripples on the surface of a pond, so does a rapidly vibrating body cause waves in the surrounding air. When a string or reed moves in one direction, it builds up a slight presure in front of it, and a high-pressure "ripple" moves away from the string.

An instant later the string moves in the opposite direction, and creates a slight rarefaction, so that a corresponding low pressure ripple follows the high pressure one. (See figure 6).

Any device which initiates similar pressure waves constitutes a source of sound. But disturbances in the air only become evident as sound when they activate our ears.

Inside each ear is a thin membrane which we know as the ear drum, and this is very sensitive to external air pressure. A slight increase in pressure causes the drum to stretch inwards and a decrease causes it to move outwards.

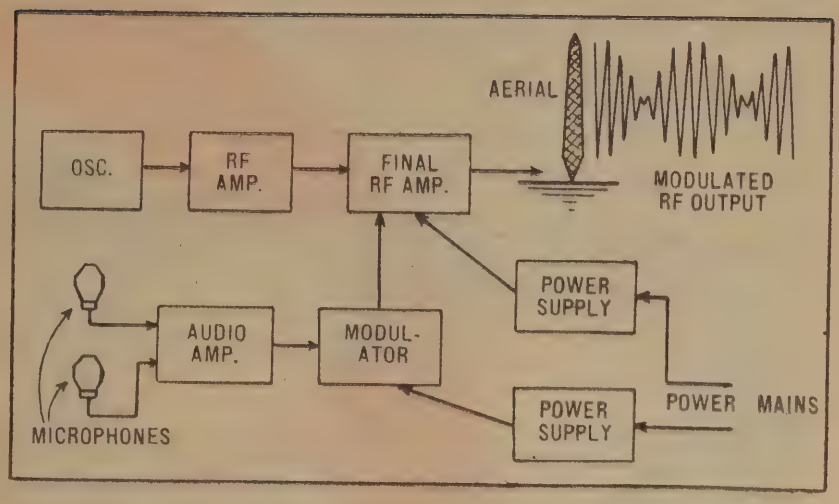

Figure 9. Here is a complete transmitting station illustrated in block schematic form.

If we happen to be nearby when our violin or piano string is vibrating, it is reasonable to expect our ear drums to be affected by the rapid variations in air pressure — that is by the pressure waves.

This is indeed exactly what happens. The ear drum vibrates in and out in sympathy with the waves emanating from the string.

The movements of the drum in each ear are communicated by a sensitive bone structure to nerve ends, which despatch corresponding impulses to the brain. Our brain interprets the impulses as sound. The intensity of the drum movement determines the impression of loudness, while the frequency of the vibration determines the musical PITCH of the sound.

BASS NOTES

Notes of a low vibration frequency, down to about 30 cycles per second, are described as BASS notes. High frequency or TREBLE notes extend to something between 10,000 to 15,000 cycles per second, beyond which our ear mechanism ceases to function.

We have assumed that a vibrating string vibrates at only one frequency at a time, but this is not necessarily true. In actual fact, its mode of vibration may be very complicated so that it generates the expected FUNDAMENTAL frequency plus a variety of so-called HARMONIC frequencies which are exact multiples of the fundamental.

The presence or absence of various harmonics determines the nature of the sound — whether it is harsh or liquid in quality, shrill or mellow.

Percussion effects, as evident in bell, piano or drum notes result from a sound impulse of complicated structure and high initial amplitude, which almost immediately resolves itself into a lower amplitude impulse of more clearly defined frequency.

The sounds we are aware of in everyday life represent a complicated series of impulses, with ever-changing characteristics of frequency, harmonic content and amplitude.

The sound pattern radiated from an orchestra is highly complex in character, containing an innumerable variety of harmonics, overtones, amplitude variations and all the rest; but, for all that, our ears and brain in combination still manage to sort it all out.

Ordinary spoken words are likewise a highly complex pattern of sound waves, originated by vocal chords and unconsciously modified in harmonic content, amplitude and general character, by the action of lips and tongue.

The essential connection between these complicated sound waves and a radio transmitter is provided by the MICROPHONE. This device has a sensitive diaphragm, which is caused to vibrate in sympathy with sound waves striking it, just as the drum in our ears.

The microphone converts the periodic variations in pressure on its diaphragm into minute electrical impulses; into alternating currents and voltages, whose amplitude, frequency and harmonic content are an exact electrical replica of the pressure variations which are the original sound waves.

In the broadcasting studio, one or perhaps several microphones are set up to intercept the sound waves generated by the announcer's voice, or by an instrumental combination, or any other sound source which may be employed.

"AUDIO" AMPLIFIERS

The microphones convert the sound faithfully into minute electrical impulses, and these are passed into a series of valve AMPLIFIER stages, where the electrical impulses are increased greatly in magnitude.

So amplified, the impulses—now known as AUDIO FREQUENCY voltages—are fed in any one of several ways into the transmitter, which we will remember is simultaneously generating and amplifying a very much higher frequency voltage for radiation into space.

In normal practice, the audio frequency voltages superimposed on the carrier tend to vary the AMPLITUDE of the latter, in the manner illustrated in figure 7. This method, employed in Australian broadcast stations, is known as AMPLITUDE MODULATION.

An alternative method of modulation (the process of superimposing a signal on a carrier wave) is to have the audio voltages vary the frequency of the car-

(Continued on Page 120)

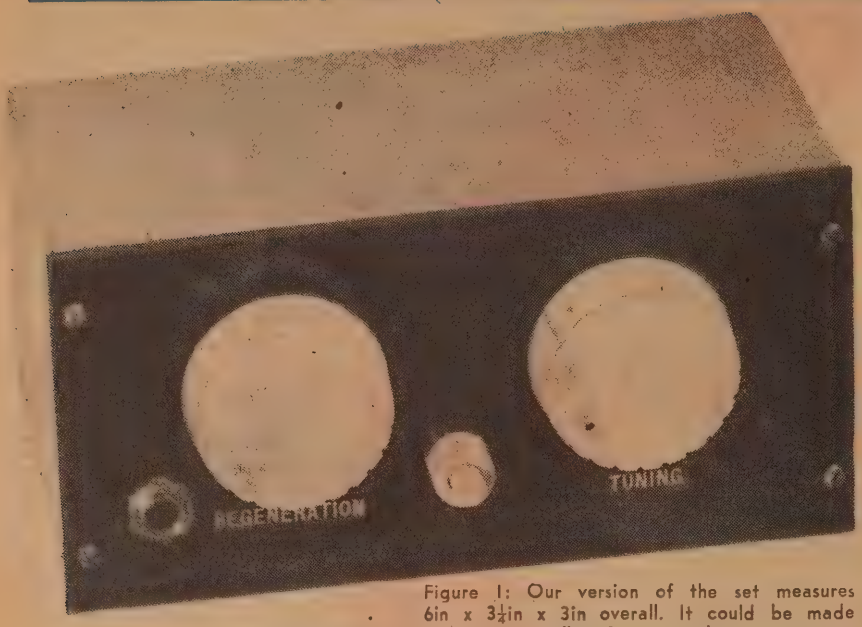

Figure 1: Our version of the set measures 6in x 3¼in x 3in overall. It could be made very much smaller if you are keen to save as much space as possible.

A Regenerative Set With Two Transistors

You've now completed last month's transistor receiver and find that you can receive most local stations at full headphone volume. But still there are some distant stations you would like to hear at better strength, or perhaps reception of the locals without a special aerial would be a worthwhile feature. The answer is a transistor amplifier stage.

by Maurice Findlay

THE actual job of adding the extra stage has so little to it that we would have difficulty in writing a full length article on the subject. At the same time there is a lot of theoretical background to the seemingly simple circuits and many of our readers starting to become familiar with transistors will appreciate some information on things like characteristic curves, bias circuits and the like.

If some of the article is a little too hard to understand fully at this stage don't worry because the set will work perfectly wired according to the circuit diagrams without any special adjustment.

EARLIER ARTICLE

You may remember last month that we talked briefly about transistors as amplifiers and set out a table giving the features, in general, of three ways of wiring them into circuit. You may remember that the common emitter arrangement appeared to be the most useful since it has medium input and output impedances combined with a high current gain.

The common base circuit has a low input impedance and high output impedance. The current gain is low (a little less than 1 with junction transistors), but the change in impedance level makes possible a high power gain when the devices coupled to the input and output of the circuit can be matched.

The common collector arrangement has a high input impedance and a low output impedance, in general, combined with a high current gain. It is useful as a matching stage, but is not used as often as the other two configurations.

The transistor in last month's receiver was wired with the emitter common to input and output circuits, but the bias was adjusted to give the best overall gain when the functions of detection and amplification were combined in the one stage.

Audio gain was not as high as is possible with a stage specially adjusted nor was the maximum power output very high. With no detector action to consider, we can concentrate on designing for gain and power output.

Data on maximum voltages, currents and dissipation are available from the transistor manufacturers. Also we can obtain characteristic curves for both input and output circuits, in the common base and common emitter arrangements at least.

DESIGN METHODS

For engineering purposes, systems have been developed to enable transistor performance to be predicted from calculations. This is a subject about which it would be possible to write a number of articles and if you haven't already had some experience with transistors, it could easily be difficult to digest.

The transistor can be considered as a network of resistances, capacitors and generators, and if the values of the resistances, capacitors and the characteristics of the generators are known, circuit performances can be calculated using basic electric circuit theory. Two useful systems are the T-network parameters and the h-parameters data for which are usually published. Equivalent network capacitors can often be omitted at audio frequencies with small error.

T-parameters are simply based on "T" arrangement of resistors in the equivalent circuit while the "h" stands for hybrid and springs from the fact that some of the parameters are resistances, some conductances and some pure numbers. These parameters vary with the operating conditions, while temperature also enters into the behaviour of the circuit. Curves giving the change in parameters with conditions are frequently available.

MOST USEFUL

Our experience with transistor calculations has not been extensive but, so far, we have found the h-parameters the most useful for predicting the performance of multi-stage audio amplifiers. The parameters apply only to small signal conditions although they often hold quite well up to the point of overload of the stage. When designing stages to operate at levels comparable with the maximum output of the transistor, it is usually best to work directly with the curves.

Transistor calculations are, in general, more involved than valve calculations. When dealing with valve amplifiers we are concerned mainly with the voltage at the grid (current is usually negligible) while, in many cases, the coupling be-

tween the output (plate) and input (grid) circuits is small enough to be neglected.

With the transistor amplifier we are mainly concerned with the alternating component of current flowing in the input circut but the input impedance is usually high enough for the voltage developed to be appreciable. There is always coupling between the input and output circuits, making transistor calculations something like valve calculations when the grid to plate capacitance is taken into account.

STANDARD CIRCUITS

You needn't decide at this stage to give transistors away altogether, because inevitably there will be some standard circuit arrangements and values evolved which will serve many cases. For example, readers who have seen valve circuits come and go will be familiar with the old "one, two, three" with the 6V6 output valve: 250 volts plate and screen, 250 ohm cathode bias resistor, &c.

Temperature is a factor which must closely concern the designer of transistor circuits, since transistor characteristics change quite drastically, particuarly at higher temperatures. A resistivé network is frequently used to stabilise operating conditions while, in some cases, temperature sensitive resistors are included for more effective control.

Let us now look at some of the factors we will have to consider in designing an output stage for our small receiver last month.

HEADPHONES

Headphones are extremely sensitive in terms of the amount of power required to give an acceptable audio level. Although it may be desirable to design the circuit to give as much output as possible, this would only be done if at the same time the gain could be made a maximum since, for the moment, at least, we are more concerned in bringing weak signals up to a level where it is possible to hear them comfortably.

The gain, in terms of power output to the headphones for a given alternating component of input current for small signal input, depends mainly on the load impedance in the transistor collector circuit. The optimum value depends to some extent on the part of the characteristic to which the transistor is biased

CIRCUIT OF 2-TRANSISTOR SET

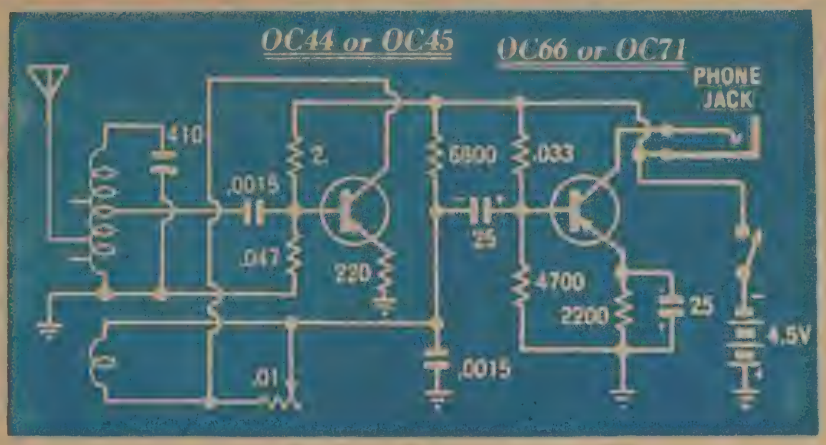

Figure 2: Circuit diagram of the complete receiver with constants suitable for headphones with a DC resistance of from 1,000 to about 4,000 ohms. Circuit arrangements are such that the set will work with full efficiency over a wide temperature range. Total current drain is about 0.3 mA and therefore batteries should last virtually their shelf life.

but will be of the order of 10,000 ohms for the OC71.

In other words, if the gain of your receiver is limited, you will get best volume by using a load impedance of 10,000 ohms. This is not the same thing as maximum power output and, in fact, if you have plenty of gain, the optimum load is about 1,000 ohms when, given appropriate bias and collector voltage, the possible power output will be many times that with the 10,000 ohm load.

The maximum steady voltage which may be applied to the collector is 5 volts, although a peak value of 10 volts is permitted. When an inductive load, such as a pair of headphones with low resistance, is placed in the collector circuit, the maximum supply voltage which can be used is 5 volts.

Both the steady and peak collector current limits are given as 10 mA. Whether the load impedance has a high or a low D.C. resistance, therefore, the centre bias position for a class A amplifier should not be greater than 5 mA. Consideration of circuits connected with temperature stabilisation may make it desirable to limit the normal steady current to slightly less than 5 mA.

Permissible collector dissipation as given by manufacturers is 25 milliwatts. it would, therefore, be possible to design the stage to operate from 5 volts at 5 mA without damaging the transistor. Note that, if, in some special circuit, steady collector current were required to be 8 mA, say, the maximum collector voltage you could apply to the transistor without exceeding dissipation figures would be about 3 volts.

STANDARD BATTERY

Since a 4.5 volt battery is already available in our little set, it would be reasonable to standardise on this value for the supply.

Before we can proceed further with the design we need to know something of the characteristics of the headphones to be used with the set. Phones vary somewhat in their characteristics and the impedance of a given pair of phones varies widely with frequency.

It is usual to quote the impedance of

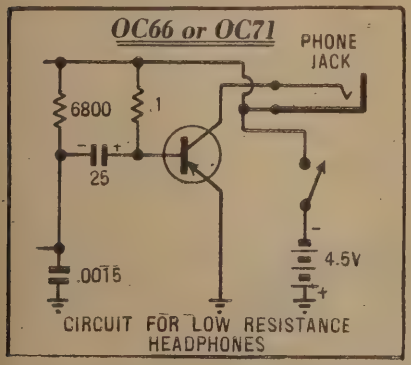

Figure 3: Use this circuit for low resistance headphones. It is not suitable for high resistance phones and if used with them, will result in small power output and high distortion.

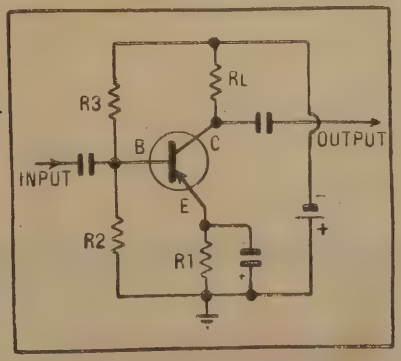

Figure 4: Where temperature changes are likely to affect the standing collector current appreciably, the above stabilising is frequently used.

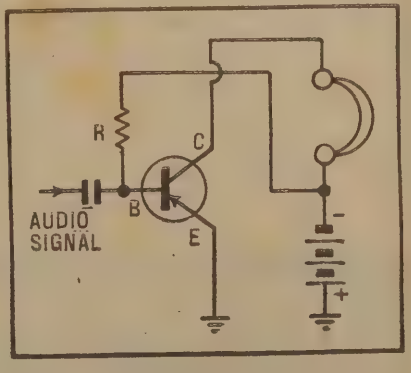

Figure 5: Forward bias is applied to a transistor amplifier simply by placing an appropriate value resistor between the high tension supply and the base.

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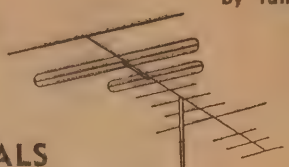

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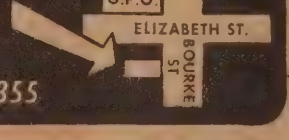

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headphones in the middle of the audio range. On this basis we found that the impedance of a typical pair of commercial phones, currently available in the shops, is 20,000 ohms. The D.C. resistance is 4,000 ohms.

A pair of disposals "low impedance" phones we checked was found to have an impedance of 800 ohms and a D.C. resistance of 130 ohms while yet another type with a moving coil mechanism had a D.C. resistance of 80 ohms and an impedance of about 100 ohms.

The last mentioned pair of phones would normally be used with a coupling transformer but there is clearly a case for determining the most suitable operating conditions for both the 20,000 ohm phones and the 800 ohm phones.

USE OF CURVES

To do this we refer to the transistor collector curves (Figure 8) where a load line is drawn for 4,000 ohms and a 4.5 volt supply. This is, in effect, a locus of D.C. operating points for the transistor.

We must now choose the particular operating point which permits the greatest excursion of current between zero current on the one hand and the non-linear portion of the characteristic near zero voltage on the other. Insufficient detail is available in the curves for the optimum forward bias to be determined with accuracy, but it is obvious that it will be very small.

If, for example, the bias is set at 20 uA (too high) the collector will be able to swing less than 1 volt toward zero voltage without distortion while it will be able to swing several volts in the other direction.

Next we should have some estimate of the optimum conditions for the 800 ohm phones in terms of power output. It can be seen from the curves that the condition for maximum power output will be obtained when the bias is about 90 uA. If the full power output is not required the bias can be reduced and a saving in standing current made. For example, with 45 uA current bias the standing current will be about 2.0 mA instead of about 5 mA as before.

CIRCUIT ARRANGEMENT

Discussion of the bias requirements may be a little vague without a specific circuit arrangement. This we have provided in Figure 5. The transistor is connected in the common emitter arrangement with the headphones in the collector circuit. An audio signal with an undistorted current waveform is fed into the base through a coupling capacitor.

Bias is required to be in the same polarity as the collector voltage and therefore can be obtained from the same battery as the collector supply. If we require a bias current of 45 uA from a 4.5 volt supply it will be necessary to set R at 50,000 ohms.

The value of R in cases such as these can be calculated with small error without taking into account the voltage drop between the base and the emitter because it is small compared with the voltage drop across R, that is, the resistance between the base and emitter is relatively small.

It is, in fact, of the order of 1,000 ohms for normal collector voltages and bias currents. For low bias currents it is higher than 1,000 ohms but it is always low compared with the value of the forward bias resistor.

This change in value does have some significance as far as audio input signal is concerned and has to be taken into account if the signal at the collector is to be undistorted.

While the circuit of Figure 5 may seem at first glance very similar to that of a conventional valve amplifier, it is soon seen that this is not the case when the circuit values are carefully considered. The audio signal supplying the base of the transistor must have a source resistance high compared with the change in resistance of the base circuit, in order that the current waveform remain undistorted. Suitable values may be of the order of two or three thousand ohms or greater.

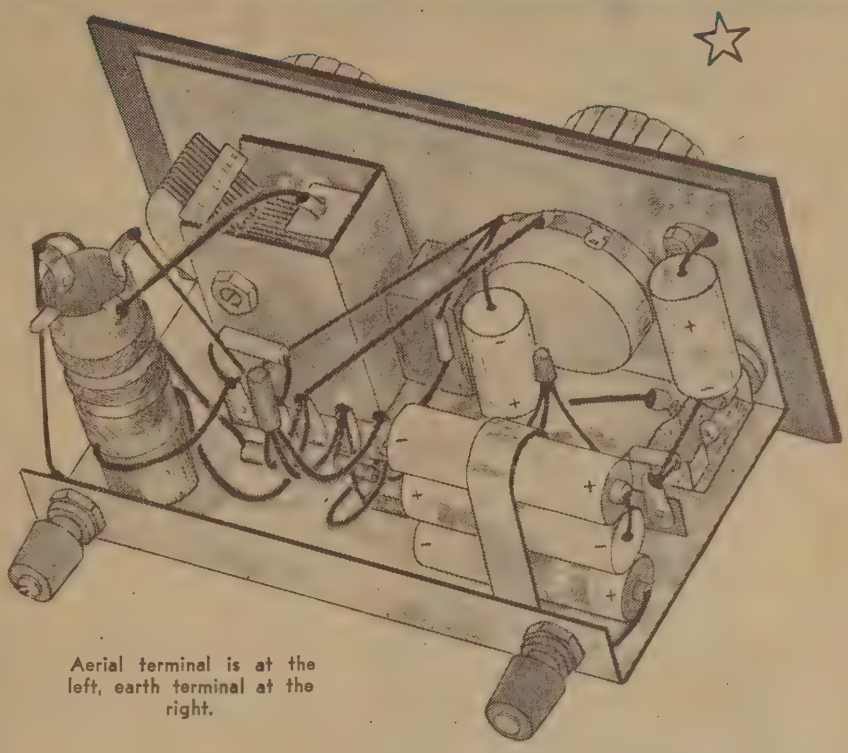
The coupling capacitor between the stages is required to have a low reactance compared with the series impedance of the drive circuit at the lowest frequency it is desired to amplify.

TYPICAL VALUES

Values of several microfarad may be required, compared with the fraction of a microfarad which is usually convenient in valve circuits. These capacitors need not be large physically, because the voltage ratings can be quite low. Special electrolytics have been made for this sort of work and no doubt will become more readily available as transistors are more widely used.

Another factor which complicates transistor circuitry, only mentioned briefly so far, is temperature. It is a subject to which we could, with profit, devote considerable space. For a full understanding it needs to be discussed on a quantitive basis rather than from the

A REAR VIEW OF THE RECEIVER



Aerial terminal is at the left, earth terminal at the right.

Figure 6: This diagram, looking from the rear, shows the placement of all major components in our own version of the set and much of the wiring. Layout is not critical, and there is nothing to stop you from making the set in any box or cabinet you may happen to have.

PARTS LIST

(For use with high resistance headphones)

Small pieces of sheet metal, bakelite and plywood for chassis, panel and cabinet.

Transistors OC44 or OC45 and OC66 or OC71.

Single section minature tuning capacitor, 410 pF. 2 0.0015 uF mica or ceramic capacitors 2 25uF electrolytics.

Potentiometer 10,000 ohms wirewound or carbon. 1 2.0 meg resistor, 1 .047 meg resistor, 1 33,000 ohm, 1 6,800 ohm, 1 4,700 ohm, 1 2,200 ohm, 1 220 ohm, resistor. (Resistors may be either ½ or 1 watt.)

Phone jack, minature switch, tag strip, terminals, three dry cells, 2 terminals, 2 knobs.

Coil is wound on ¾in diam. former. Tuned winding is wound to a length of 1¼in with 32 B & S wire and tapped at 1/8in, ¼in, ½in and ¾in. Reaction winding is wound to a length of 3/8in with 36 B & S wire.

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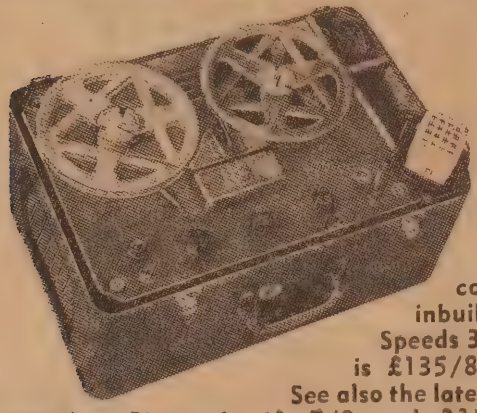

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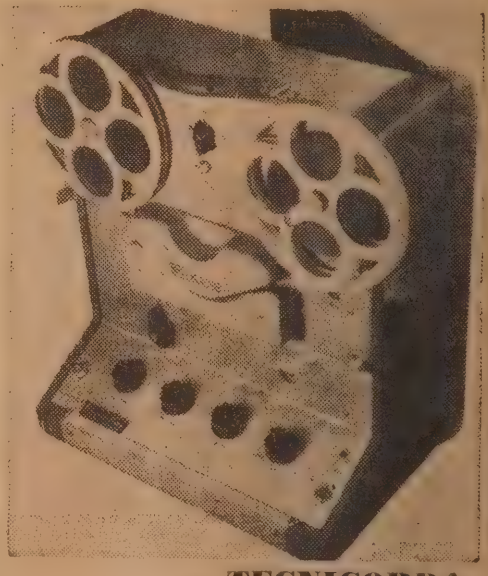

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very general point of view, as so far in this article.

It is necessary to say a little more about the effects of temperature, if only to explain the presence of a number of additional components in the circuit for use with the high impedance phones.

Looking at the collector characteristic family of curves (Figure 8) it is seen that the collector current is affected both by the base current and by the voltage applied to the collector. The voltage has a secondary effect because of the high dynamic resistance of the collector circuit.

CURRENT GAIN

To take a specific case, if the collector potential is set at 2.0 volts, with the base current at zero, the collector current will be about 0.15 mA. If the base current is increased to 40 uA, the collector current will increase to 2 mA. In other words, the change in collector current is a little less than 50 times the change in base current.

If now, we increase the collector voltage from 2 to 4 volts, the collector current will increase from 2 mA to 2.2 mA only because of the high resistance of the collector circuit.

The information applies only at a nominal junction temperature quoted by the manufacturer. This is usually 25 degrees centigrade (77 degrees F.). If the temperature is increased, the collector current for any bias or collector current will increase. In other words, the entire set of collector current curves will move upwards.

Naturally this could not go on without limit because eventually the collector current would become high, even without forward bias current. and the dissipation rating for the transistor exceeded. Obviously dissipation and temperature are closely connected, but even when there is extremely small power being dissipated, there is a limit to the permissible junction temperature, due to the physical effects on the germanium.

The temperature of the surrounding air will be less than the junction temperature, when the transistor is dissipating its full rated power. Usually the manufacturer gives maximum ambient temperature when the transistor is dissipating its full rated power. In the case of the OC71, this is 45 degrees centigrade (113 degrees F.).

DC STABILITY

Data is given by manufacturers from which the actual change in collector current for a given change in temperature can be calculated. The voltage applied to the collector does have some effect on the temperature dependant collector current, but in most cases this can be neglected and the temperature increase considered to move the entire set of collector characteristic curves in the direction of higher current.

On the basis of manufacturers' data, the change in collector current, when the temperature changes from 25 degrees centigrade to 45 degrees centigrade would result in an increase in collector current of about 1.5 mA.

Now, in our case, the collector circuit resistance (the DC resistance of the headphones) is 4,000 ohms. Obviously, with the supply of only 4.5 volts by a simple ohm's law calculation, the current cannot be 1.5 mA. What actually happens is that the transistor current increases until the voltage is about 0.2 volts, and the transistor characteristic is no longer

LAYOUT DIAGRAM OF RECEIVER

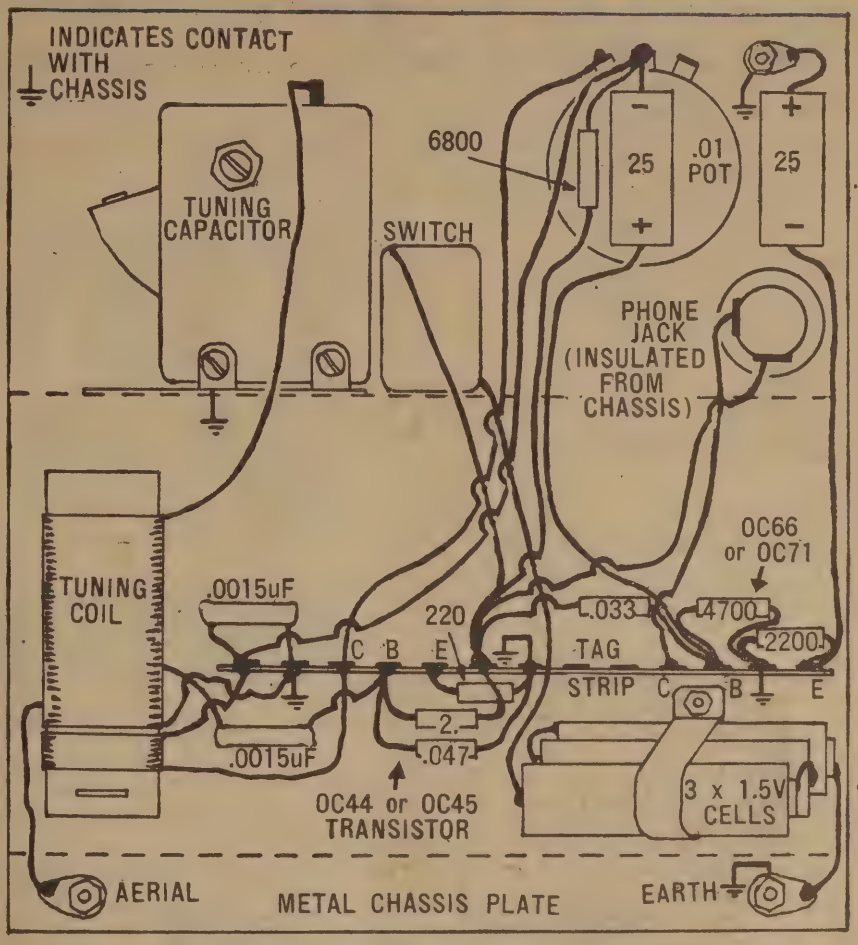

Figure 7: All wires and wiring components are shown in this diagram in which the chassis is bent out flat. Transistors are not drawn to avoid confusion, but their connections are marked C, B & E standing for collector, base and emitter respectively.

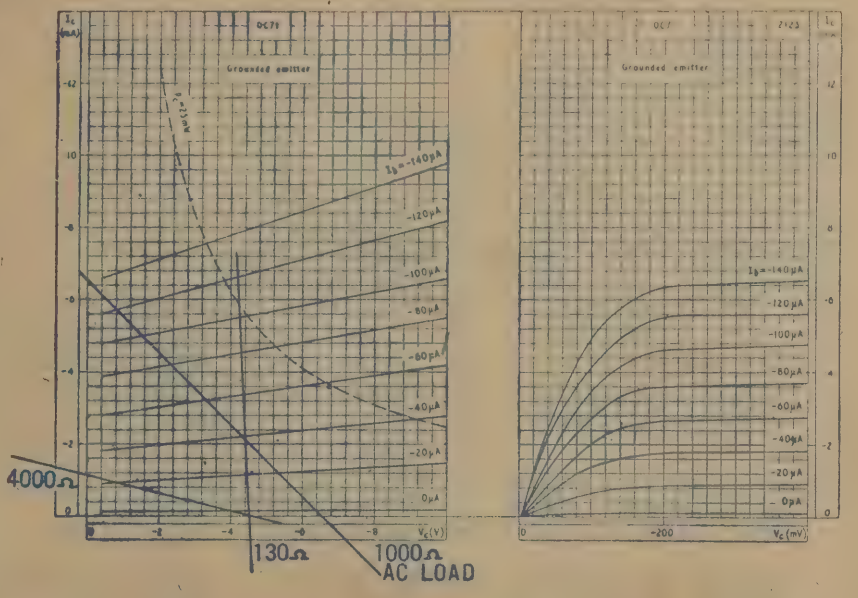

Figure 8: Output characteristic curves for transistor type OC71 from the Mullard Technical Handbook. Load lines illustrate points made in the article. Detailed curve at the right is very useful for designing circuits to work at very low voltages. The 4,000 ohm load drawn from Vc equals 4.5 volts gives possible operating points for high resistance phones. The AC load is not drawn. DC resistance of normal low resistance phones is about 130 ohms and impedance 1,000 ohms. (Not always resistive as shown) It can be seen that max. power output could be increased by increasing forward bias to about –80 uA in the latter case.

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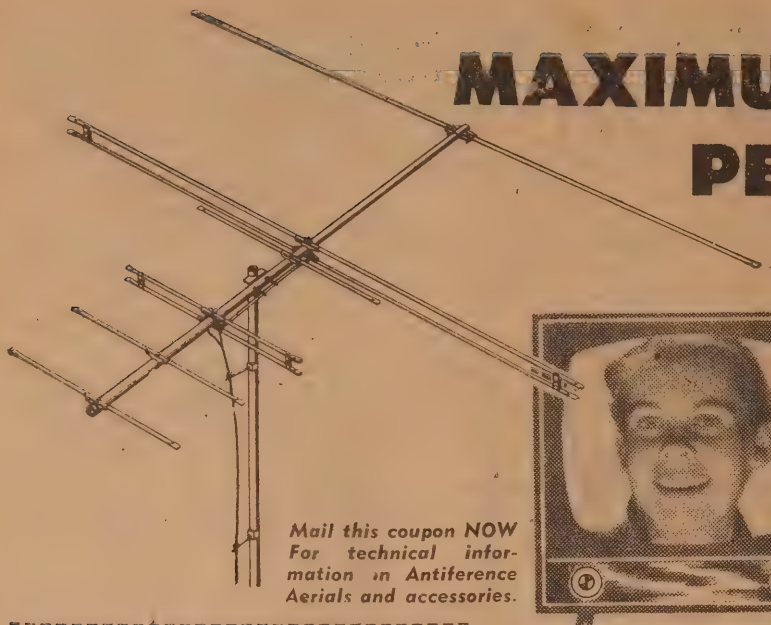

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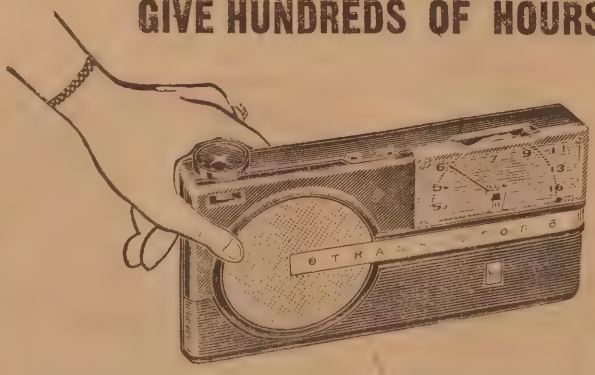

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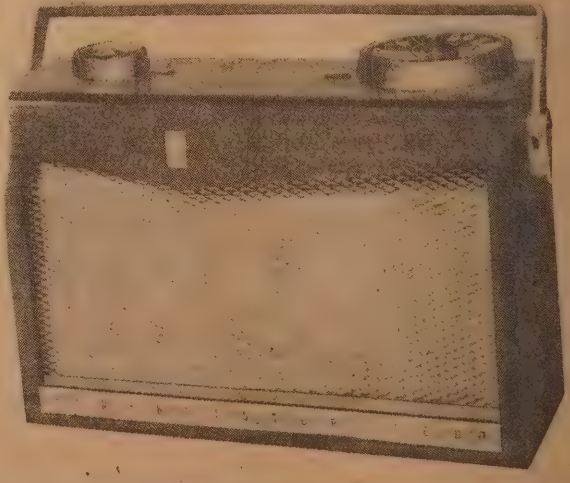

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linear. The collector current would then be about 1.0 mA.

The transistor remains in this condition unless a very strong signal is applied to reduce the collector current, in which case it will reproduce a very distorted version of the input current in the collector circuit. It should be fairly obvious that a simple series resistor bias circuit (Figure 5) is not suitable for operation at high temperatures, when there is a high resistance in the collector circuit.

The arrangement frequently used in practice to stabilise the operating point is given in Figure 4, where RL is the load resistance. In our case it is an impedance, since the headphones have an inductive component, but as far as the DC operating point is concerned, only the DC resistance is of interest.

R1 is roughly analogous with the cathode bias resistor familiar to valve users. Emitter current flowing through this resistor results in a voltage drop and the emitter assumes a potential negative with respect to ground.

The voltage divider R2 and R3 tends to establish a negative potential for the base of the transistor. This potential will vary as the base current varies. The amount of the variation will depend on the values of R2 and R3, the lower the values of the resistors the less the variation.

Now, if the current through the collector and emitter circuit increases because of increase in temperature the voltage drop across R1 increases, making the potential of both the emitter and the base more negative with respect to earth. This has the effect of reducing the current flowing in the base circuit and hence, because of the amplifying action of the transistor, the current flowing in the collector and emitter circuits.

POWER WASTE

In other words, it tends to stabilise the operating point of the transistor.

Very rarely do we get anything for nothing in this world, and so it is with the DC stabilising circuit. First of all, power is wasted in the emitter series resistor and also power is wasted in the divider network. Often it is a question of choosing a suitable compromise between operating point stability and power wasted.

Values of resistors for a given current increase corresponding with a given temperature rise can be calculated fairly readily. The circuit we have given for use with high resistance headphones is designed for a normal collector current of 0.2 mA at 25 degrees centigrade, while at 45 degrees centigrade, the forward current will be about 0.3 mA. The undistorted power output at the higher temperature will not be as great as at normal temperatures, but still sufficient to give quite good volume.

High impedance phones will give the best gain, but many will wish to use low impedance phones, such as those available from disposals sources. Since the DC resistance is low, it is possible to choose a forward bias which will make the collector current at normal temperatures high enough for good power output but at the same time low enough for the sum of normal collector current and leakage collector current at high temperatures not to exceed the permissible value.

LOW IMPEDANCE PHONES

For low impedance phones, we suggest a simple forward bias resistor of 0.1 megohms when the collector current at normal temperatures will be about 2.0 mA. No special stabilising circuits are necessary. The current will increase to about 3.5 mA at high temperatures, but the transistor will still be able to deliver adequate audio power without running into distortion.

Addition of the amplifier stage to the small receiver described in detail last month is so simple that special comment is hardly necessary.

If you intend to use the set with low resistance headphones the extra components are the transistor, a capacitor and a resistor. For the high impedance phones, you will need a capacitor and two resistors above this.

In either case, the parts can be soldered to a tag strip mounted between the batteries and the front panel and in line with the earlier tag strip.

Take out the batteries temporarily and mount all components other than the transistor. The coupling capacitor from the collector circuit of the first transistor to the base of the amplifier transistor can most conveniently be anchored between the potentiometer and one of the lugs of the tag strip.

The transistor can be soldered into circuit when you are sure that everything else is in order. Leave the leads of of the transistor fairly long in case you wish to use it later in another receiver or amplifier. The transistor may be damaged by thermal shock and we advise that you hold each lead with a pair of long nose pliers while carrying out the solder job. Leave the pliers in place long enough for the lug to cool, otherwise some of its heat will be transferred after the pliers are removed.

We have heard of cases where transistors have been damaged due to their being soldered into circuit with soldering irons having leakage between the element and the copper bit. Make sure first of all that your soldering iron does not have any obvious leakage and then disconnect the set from all external circuits while doing the soldering job.

The circuit has been designed for either the OC71 or the OC66 transistors and either will work equally well. It is, in fact, an OC66 which appears in the photographs. We have not tried the OC70 or the OC65 but both would probably work well. All these transistors have been reduced in price by a worthwhile amount making the addition of the transistor stage cheaper than adding a valve to a simple regenerative receiver.

RESISTOR TYPES

If you are buying the resistors new, we suggest that you choose ½-watt types as they are cheaper and more compact. At the same time, there is nothing to stop you using 1 watt resistors you may have on hand.

The two coupling capacitors are 25 mfd types rated to withstand a 40 volt surge voltage and are available in several brands. Special compact electrolytic capacitors rated at very low voltages are available and gradually becoming more plentiful. Items of this nature are essential when it comes to building hearing aid amplifiers into spectacle frames and the like, but their extra cost is not warranted in our case.

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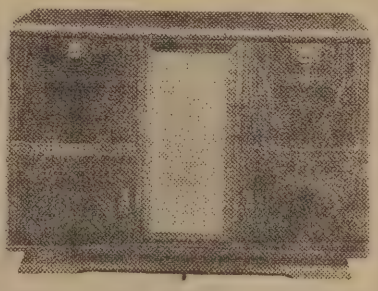

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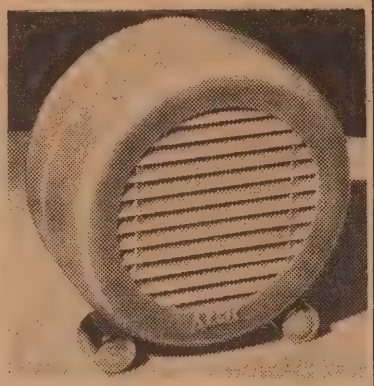

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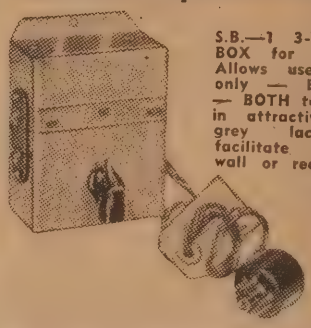

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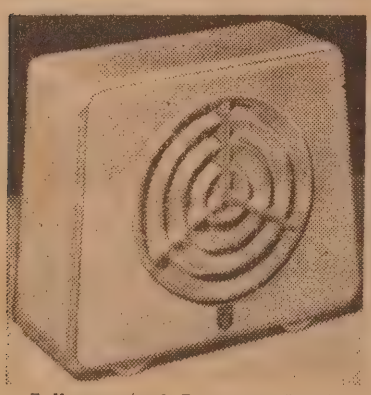

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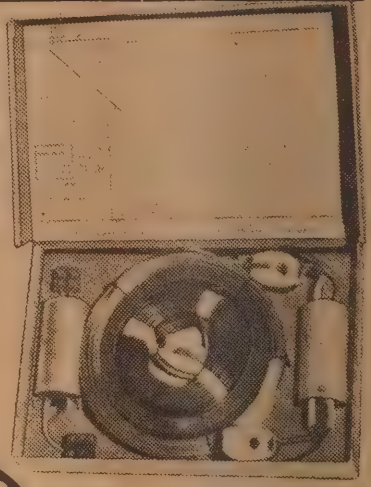

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FROM THE SERVICEMAN WHO TELLS

My prize story this month is not merely unusu al but, as far as I'm concerned, definitely unique. Perhaps I'm sticking my neck out, but I'll be be very surprised if anything like it has ever been reported before. Furthermore, it could expla in some previously inexplicable "funny effects".

HOWEVER, the story will make most sense if I start at the beginning. It concerns an American communications receiver which one of the "ham" fraternity had acquired and which exhibited a most unusual behavior in the AVC circuit, as well as having some distortion in the audio system.

After one or two unsuccessful attempts to solve the trouble himself, the owner passed the set over to another "ham" who was rather better equipped to tackle the job. The latter happened to be a colleague of mine, and it was from him that the story originated.

His first impression of the set was that there was certainly something "very funny" about the AVC system; an effect quite unlike anything he had ever struck before. He described it as making the set extremely difficult to tune accurately, there appearing to be an excessive time delay in the AVC action but made worse by the fact that it was not entirely consistent.

FAST AND SLOW

Thus, as a station was tuned in, the AVC appeared to take a long time, i.e., seconds, to adjust itself to the incoming signal; while the reverse appeared to be true when the station was tuned out, the AVC adapting itself to the changed condition quite rapidly.

In other words, the AVC was extremely sluggish in an upward direction, but appeared to be normal in a downward direction. Frankly, I can't think of anything better calculated to drive a "ham" operator balmy in short order.

On the face of it, my colleague could think of no logical explanation as to why any AVC system should behave in this manner, so he merely adopted the attitude of checking all components in the line as thoroughly as possible.

Nothing appeared to be abnormal until he commenced checking the bypass capacitors for leakage, using the high ohms range of a VTVM. The first indication that something was wrong was when the meter read backward, in spite of the fact that the set was switched off.

FOREIGN VOLTAGE

Further investigation with the VTVM —as a voltmeter now—showed that there was something like three volts positive present on the AVC line, but without any logical source of power to supply it.

There followed a systematic unsoldering of leads to isolate completely the line from any possible voltages present in other parts of the set—but still the mysterious voltage remained.

It wasn't until the AVC line itself was broken apart that the culprit was finally run to earth. Imagine my colleague's reaction when he discovered that the voltage was being generated by the AVC by-pass capacitors. There were three in the AVC line and each one would deflect the VTVM when completely removed from the circuit.

Nor was it any residual charge effect. Apart from an initial drop of about 10 pc, the voltage remained essentially constant while ever the capacitor was connected to the VTVM.

Thus alerted, he checked other capacitors in the set, finding one more serving as a coupling device between the noise limiter and the first audio stage. This one wasn't as bad as the others, generating only about half a volt, but this was enough to upset the operation of the audio stage and create the distortion previously noticed.

When he first told me this story, I was frankly incredulous, and I said as

"Sorry, mate — there's no Smith here who wants his set converted!"

much in the special diplomatic language which servicemen and radio technicians reserve for such occasions.

"I thought you'd say that," said my colleague. "Come into the workshop and I'll show you."

Whereupon he led me up to the VTVM, handed me the leads and the suspect capacitor, and said:

"There you are, try it for yourself. This one should read about half a volt."

I did. The meter read .5 volt initially, dropping slowly to about .3, at which it appeared to become more or less stationary. I removed it from the test leads, shorted them, checked the VTVM for zero and possible false readings, but could find nothing abnormal.

I measured the capacitor again. It had risen to .45 during the few minutes it had been on the bench, dropping as before to about .3. Muttering something about fixing the thing properly, I removed it from the meter once more and bridged the two pigtails with a scrap of tinned copper wire on the bench.

I left it in place for half a minute or so, then put the capacitor back on the meter. It read .15 volt.

"Satisfied?" asked my colleague.

I shook my head, not as an answer to his query, but in straight out bewilderment. "You win," I replied. "But I still can't see how it happens."

He shrugged his shoulders. "Nor I. All I know is that it is happening and that it gummed up that communications set. I'll leave the reason for someone else to explain."

STILL GENERATING

That was several days ago. As I write, the same capacitor is resting on my table. I checked it again on my own VTVM a few moments ago and it swung the needle up to .5 volt, then dropped much as it did before. Presumably it is likely to go on generating voltage for a long time yet.

And the reason behind all this? Well, it's easy enough to see—now—why the AVC line behaved so erratically. Before the negative voltage generated by the diode could become effective, it would have to discharge the positive voltage generated by the capacitors and then commence to build up the required negative voltage. No wonder its response was sluggish.

Presumably, the energy in the AVC line was high enough to maintain something like the correct bias while ever the station was tuned in, but reverted rapidly to the positive bias condition immediately this was removed. Hence the apparently normal AVC response in the downward direction.

WHY DOES IT HAPPEN?

As for the capacitors themselves—well, I'm afraid I pass on that one for the moment. My first reaction was that acid content in the insulating paper could be acting as the electrolyte for a crude cell. Unfortunately, the flaw in this theory is that both plates of such a cell would be of identical material. This being so, how could a potential difference be produced?

I rang a couple of acquaintances who work in local capacitor factories and who should, by virtue of their respective positions, be well acquainted with such phenomena if it is at all common. Both assured me they had never heard of it before and both expressed an eagerness to submit my sample to a laboratory test.

Since I personally had only one such

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sample, they may have to fight it out between them, but I am hoping that I will be able to get some kind of an explanation for the phenomena.

In the meantime, I have been conducting my own private witch hunt. Grabbing a handful of new capacitors from the workshop bin, I submitted them all to the VTVM test. Strangely enough, most of them showed some evidence of voltage, even though it was a negligible amount.

In a few cases it was comparable with the one I have been discussing, while one specimen sent the needle hard over past the 3-volt mark at the end of the scale.

However, in all cases the voltage quickly dropped to virtually zero, and I cannot be sure whether the effect was due to a trace of energy left over from the final test, or whether it was self-generated. The three-volt one, at least, looks as though it might be one of the latter. I have shorted it out for half an hour or so and intend to leave it for a day or two to see if it will acquire a charge without assistance.

NOT THE SAME

In any case, none of those that I have tested have been the same as the original, inasmuch as they all exhibited a very high internal resistance and whatever voltage was present dropped very rapidly. They would be hardly likely to upset the performance of a receiver.

But it may mean something to capacitor manufacturers, who see in such strange behavior possible evidence of electrolysis or dissimilar-metal effects which might ultimately react on the quality and life of their component.

So there, for the moment, the matter rests. As I said at the beginning, it is a completely new fault as far as I am concerned, though I am prepared to believe that someone will come up with a similar experience. All I hope at the moment is that none of these "live" capacitors—if they exist locally—find their way into the current crop of TV receivers. That, I imagine, could be a really nasty one.

Swinging to the other end of the scale, my next story concerns nothing more pretentious than a crystal set. The mere fact that I don't have to service such devices very often adds some interest to the story, while one of the causes of failure was rather unusual.

SOCIAL JOB

As so often happens, this incident started outside office hours, while on a social call. My host was a fellow who had dabbled in radio to some degree, mainly to the extent of building a few simple receivers and amplifiers, thereby acquiring at least a rudimentary grasp of basic principles.

I wasn't altogether surprised, therefore, when he waited only long enough to exchange the usual polite pleasantries before he exclaimed, "I've a curly little radio problem all lined up for you. You'll have to earn your afternoon tea today."

As I say, I wasn't surprised at this, but I quailed inwardly just the same. Was it his TV set? (he had just acquired one), or was it his car radio? (he has one of those, too), and what was "curly" about it? At that particular moment, I had never felt less like tackling an intermittent in either a car radio or a TV set.

Some of my inward reaction must have shown, because he grinned and added, "Oh, it's not that bad, really, just a rather puzzling behavior on the part of the boy's crystal set. But the trouble is, I hardly know where to start checking. After all, there's nothing in the thing."

Then I remembered. His son—a lad between the age of picture books and long pants—had recently shown an interest in radio, electricity, and kindred subjects, and his father had wisely encouraged him in his hobby.

The first project was a crystal set and, with a discreet amount of help from Dad (both financial and technical) the lad had made quite a good job of it. The last I had heard it was receiving several local programs—separately—and had been installed in his bedroom as a bedside set.

Now, apparently, it was on the blink, and I must confess that I felt much the same as my host about the problem. Just where does one start to check a crystal set? Apart from obvious things which can be checked visually, there isn't much that can go wrong, particulary in a set that has previously functioned successfully.

All of which, seemingly, suggests a rather contradictory situation, whereby a crystal set becomes a difficult set to service because there is so little in it that one can check. This is not really true, of course, but it is true that checking a crystal set presents its own particular problems.

LITTLE PRACTICE

For one thing, very few of us have the chance to acquire sufficient practical experience on these simple sets. Thus, when faced with a problem, we have no standard against which to judge performance. For another, performance is so dependent on location, efficiency of the aerial-earth system, condition of the phones, etc., that it is difficult to decide whether the fault is with these things, the set itself, or combination of both.

In the circumstances I reasoned that a faulty detector would be a most likely diagnosis, even though these are usually pretty robust. I said as much to my host as we made our way to the set, but he rather dashed my hopes by pointing out that he had already thought of this and had tried two other detectors without any improvement.

By this time we had the set in front of us and I gave it a quick visual check. There didn't appear to be anything obviously wrong and I slipped the phones on and twiddled the dial. I managed to pick up one station—a nearby one—but it was extremely weak and badly distorted into the bargain.

Then I raised the question of the detector again. The one in the set at the moment was one of the early copper-oxide types, diodes, which, as I remembered them, were rather less efficient than the modern germanium types.

The first thing I wanted to know was where it came from and what chance there was that it was any good, anyway. To this the lad replied that it was one of two which had been passed on to him by a well-meaning friend who had come across them while clearing out some old radio gear. Then he added:

"It used to work best with this white one. That was the one I put in it first. I could hear the bloke next door with it, as well as the proper stations."

"The bloke next door?" I queried.

"HAM" SIGNALS

"There used to be a 'ham' next door," explained my host. "He's moved away now. He used to put a solid signal into the crystal set when he was on 80 metres. Not surprising really, seeing that our aerial was parallel with his and only a few feet from it."

"What about the other one you were given?" I asked.

"Oh, it won't work at all with that one," said the lad, "and it only just works with the one in it now."

"And the white one?"

"Doesn't work at all with that now, either," he replied.

By now a possible theory was beginning to form in my mind. First, there seemed more than a chance that the two copper-oxide diodes had "had it" even before they were passed over to the lad. If this were so they would only have clouded the issue when used as a basis for comparison.

The second point was the very real possibility that the blast of signal from the "ham" on 80 metres had proved too much for original germanium diode, bringing about the failure of what should

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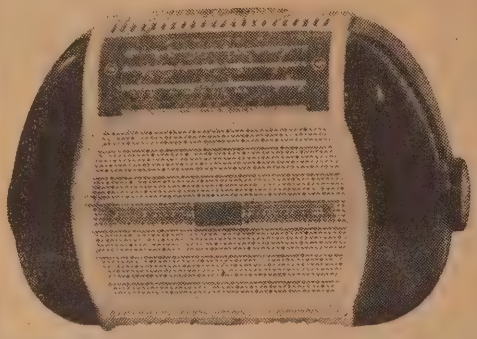

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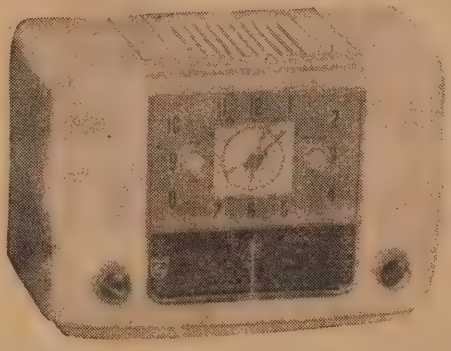

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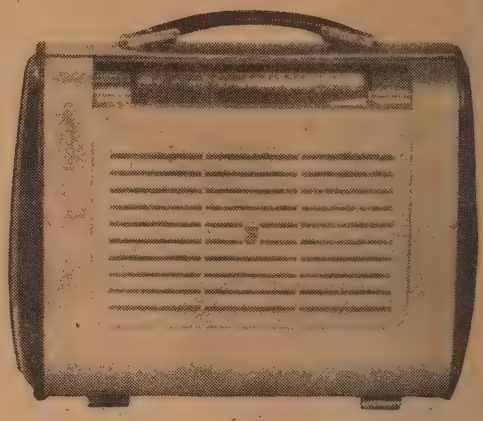

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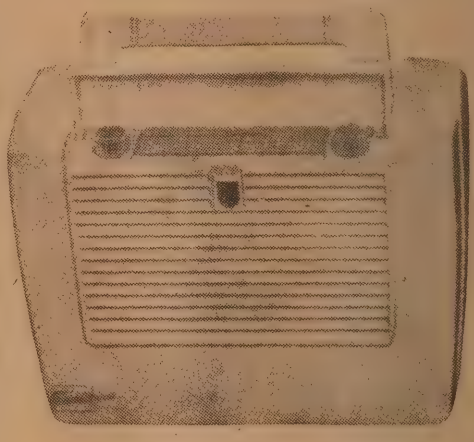

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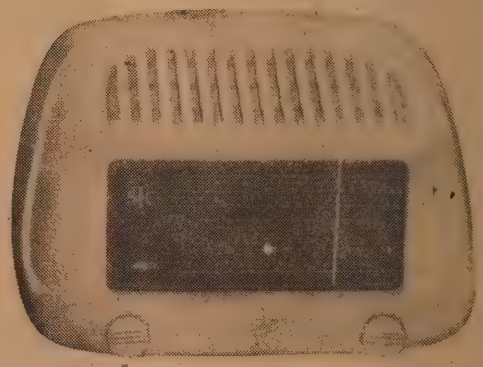

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otherwise be an almost everlasting device.

I expounded this theory to my host and suggested that he let me take the set and the assortment of detectors back to the workshop. At least I could try the set with a known good diode, and compare the performance with that of the suspect ones. Until then there didn't seem to be much more I could do.

"And," I added, "you'll have to give me my afternoon tea on trust after all."

Back at the workshop next day I selected the best aerial I had, plus a good earth, and tried the set again. Its performance was much as before, still using the original copper-oxide diode. As a matter of interest I removed this and checked it on the ohm meter. In one direction it showed 4500 ohms and in the other open circuit; figures which didn't mean a great deal at the time.

HIGHER RESISTANCE

However, I checked copper-oxide diode No. 2 (the one that was supposedly dud) and found it had 75,000 ohms in one direction and was O/C in reverse. Well, at least that seemed logical. To prove the point I wired it into the set and confirmed the lad's story that it was useless.

Next I checked the germanium diode, only to find that it was completely O/C in both directions. In these circumstances there didn't seem to be much point in checking it in the set.

Having thus established some basis for comparison I fished out a couple of germanium diodes I had on hand and put them across the ohm meter. No. 1 — of uncertain age and origin — measured 500 ohms in one direction and 35,000 in reverse. No. 2 — a brand new one — did even better; it showed 400 ohms one way and 250,000 ohms in reverse. Both these figures seemed more logical than the previous ones.

In the set, No. 1 performed many times better than the defunct copper-oxide, and more in the manner that I expected a crystal set to work. No. 2 was even better, though the difference was not oustanding. Still, the fact that it was noticeable was significant, and established the validity of the ohm meter test in terms of probable performance, at least on a rule-of-thumb basis.

Later that afternoon an excited schoolboy who had hurried around from school "on spec." put on the phones and listened to his set. He twiddled the dial, checked the number of stations he could hear, listened intently to each one, then asked:

"What was wrong with it?"

"A faulty crystal," I replied, then added, "How do you like it now?"

"Aw gee, its real beaut."

And that, from any schoolboy, is praise indeed.

CAR TROUBLES

To round things off for the month here is a simple incident from real life.

I was pottering around the garden on a recent Saturday afternoon, when I became aware of a couple of energetic types out in the street, working on a car. By their voices I identified them as near neighbours who had recently acquired a not-so-new car.

(Continued on Page 120)

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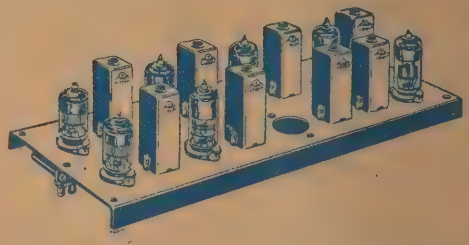

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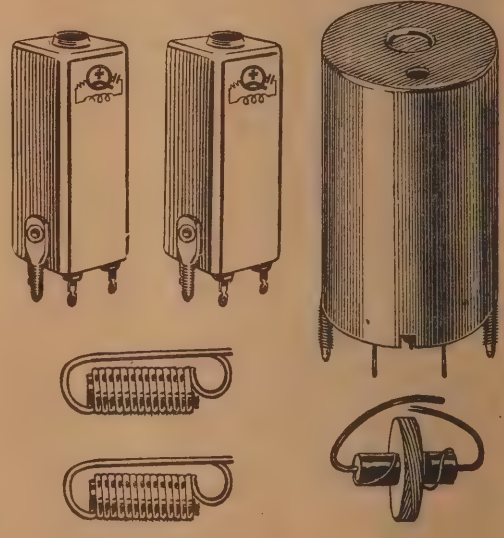

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A READER BUILT IT!

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DESIGN FOR RESISTANCE CAPACITY RUMBLE FILTER

A reader from Bulimba, Queensland, Mr. H. Swan writes regarding his experiences with a commercial record player fitted with a crystal pickup. He noticed that on certain microgroove recordings, where the gain control had to be advanced, the rumble level was too high for pleasant listening and found the solution to his problems in a resistance capacity network.

MR. SWAN tells his own story: "At the end of last year I built up a radiogram following the circuit of the "Wide-Band Six" with some modifications to the audio end. I used a pair of Stentorian speakers (woofer and tweeter with crossover) and a commercial record player with a crystal pickup.

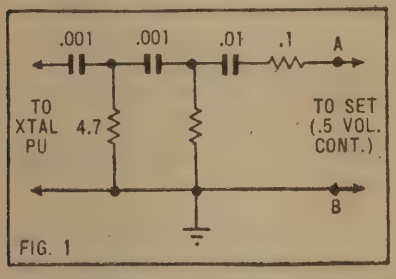


FIG. 1

Everything worked out perfectly but for one fact. The record player proved to have a certain amount of inherent rumble which was very annoying on low level microgroove records.

As record players don't grow on trees, I set to work to design a suitable rumble filter and came up with the accompanying circuit (Figure 1) which did the job very effectively.

The whole device was built up in a metal box fitted with a pair of terminals for the input and a short shielded lead for the output.

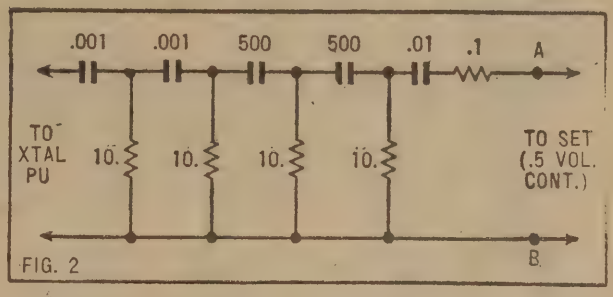


FIG. 2

Anyone who would like to get rid of the treble pre-emphasis on microgrooves could try connecting a 500 pf capacitor between A and B.

For an amplifier fitted with a 1 meg. volume control the 0.1 meg. resistor in the "hot" output lead could be omitted.

As a matter of fact, if my calculations are correct, this network gives approximately an RIAA roll-off to the bass.

This circuit (Figure 1) should be all that is required with any single ended amplifier as most of these drop off very steeply below 30 c/s. Anyone with a push-pull amplifier would be well advised to use the larger network (Figure 2).

Knowing the number of people using motor pickup combinations with extended range amplifiers I feel sure that many of your readers will appreciate the information.

A SIMPLE AMPLIFIER FOR A CRYSTAL SET

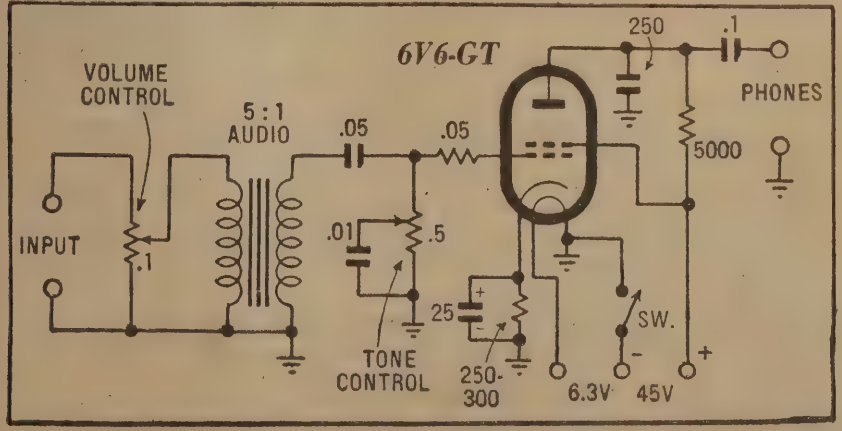
MASTER IAN WILSON, Bensville, via Woy Woy, NSW, writes: "I enclose a circuit of my own design for a small one valve amplifier that you may find fit to publish in the "Reader Built It" columns of your magazine.

"I found that the amplifier works extremely well on a crystal set and could be used on small one or two valve sets. It can easily be constructed on a chassis measuring 5in x 4in x 2in."

Voltages are not critical, the greater the high tension voltage the greater the maximum power output. Actually the 6V6-G is frequently used as a power output valve in mains operated receivers where the high tension is up to 250 volts.

The valve would probably work quite well with the filament on a 5 volt supply. On the other hand it should not exceed 7.5 volts.

For greatest voltage gain the audio transformer could be connected the other way around although the change would have an effect on the frequency response. Finally, the .05 mfd capacitor in the "hot" secondary lead may not be necessary.

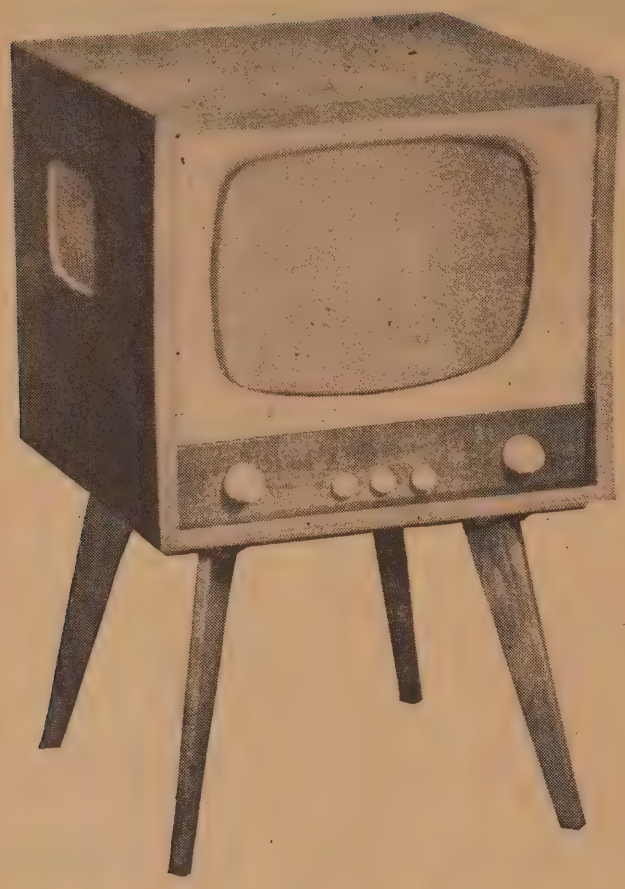


USING OLD FLUORESCENT TUBES

IT is still possible to use fluorescent tubes which have the filament burnt out. While not an economic proposition in the normal way, there may be some readers who happen to have the parts on hand and would like to use tubes which have been discarded because one or both filaments are burnt out.

Mr. B. Sargent, of Earlwood, NSW, suggests connecting the tube across the 770 volt full secondary of a power transformer in series with an ordinary filament type lamp to limit the current to a suitable value. (Obviously, the tube cannot be used without some limiting device, otherwise an enormous current will flow).

For a 40 watt tube Mr. Sargent has found that a 60 watt filament lamp is suitable or a 30 watt lamp for a normal 20 watt tube. Connect the filament pins together at each end of the tube.



Here is the cabinet design we suggest for your completed receiver. It can be built without special skill or special tools and shouldn't cost more than five or six pounds. The knobs are standard radio types, which can be adapted easily for use with this receiver. The design is already being copied and adapted for commercial sale.

PART THREE

OUR 17-inch TELEVISION SET

Here is the third and final major article on the RT & H 17-inch television receiver. It details construction of the cabinet, mounting arrangements for the picture tube and the final setting up of the receiver to ensure optimum results.

ALTHOUGH presented as the last major article, this will certainly not be our last word on the receiver. On a project which is so new and of such magnitude, readers are likely to raise many points about construction and adjustment which have not specifically been covered in the original articles.

Assuming, however, that you have completed wiring of the chassis, as described last month, the next step is to build the cabinet and thus provide a safe housing for the picture tube during final testing.

If you choose rather to test the set with the tube propped up on the table, you do so at your own risk!

CHASSIS MOUNTING?

Some readers, alternatively, may decide to mount the picture tube on the chassis itself, as in many commercial receivers. Since we have not adopted this method, we are not in a position at this stage to make any specific recommendations about the best way to go about it.

However, if you have ideas along these lines, it would be a wise precaution to examine methods used in commercial receivers.

The usual method is to clamp the tube around the front edge of the bulb, with rubber or felt cushioning to distribute the pressure. The yoke is supported independently but linked to the front clamp to ensure rigidity. No strain must be placed on the neck of the tube.

With the tube attached to the chassis, it is often necessary to provide additional metalwork or a cradle, so that the chassis can be rolled over for work underneath. Care is necessary, also, to avoid scratching the tube or hitting it accidentally, with tools.

In the cabinet design, illustrated above, the bottom of the tube face is about 1 7/8in above the surface of the chassis, which should allow ample room for a cradle, while also allowing the tube to clear the tuner.

Manufacturers expressly stipulate that picture tubes should not be exposed or handled unless all persons in the vicinity are wearing shatter-proof goggles.

While, in practice, the stipulation appears to be honoured more in the breach than otherwise, it stands nevertheless.

It was largely to avoid these complications that we mounted the tube as we did.

COMPLETELY NEW CABINET

As you will see from the accompanying photograph, we have completely re-styled the cabinet, so that it is both modern and attractive in appearance. It incorporates the lessons learned in the design illustrated in earlier issues, yet is actually simpler to construct. Properly finished, it is worthy of a place in any lounge room.

In revising the design, we have brought the knobs inside the front alignment of the cabinet, reducing the length of all control shafts by a full inch. This makes it possible to use a standard tandem pot. for the "Gain-Brightness" control, with an approximate 2-inch outer and 2½-inch inner shaft.

The same reduction applies to the tuner shafts and over-rides earlier remarks on this point.

Apart from being mechanically helpful, the new position for the knobs and a concave finish to the front vertical edges of the cabinet give the set a neater, more compact appearance.

TWO POSSIBLE POSITIONS

The speaker can mount on either side of the cabinet, depending on which position best serves the viewing room. Alternatively, you may choose to fit two speakers, operating them in parallel but with the cones phased to give reinforcement rather than cancellation at the bass end.

To build the cabinet, as illustrated, you need only a single 6ft x 3ft sheet of half-inch plywood, plus a few additional scraps that will not worry any home handyman. In fact, if you make or buy a set of "Swedish" legs, enough plywood can be saved from the full sheet to make a table or "swivel-base" to carry the cabinet in the modern mode.

The cabinet in the photograph is resting on just such a table.

Whether you follow this design in detail, however, is a matter of personal choice. Some may prefer to buy extra timber and build a full or semi-console style, with the speaker below the receiver proper and facing forward. The same basic mounting arrangements and the same dimensions can be used for the chassis shelf, the tube and the safety glass.

Again, the cabinet could be widened and the chassis mounted vertically against the right-hand side. This would bring the tuning controls to the top right-hand corner with

the other knobs in line below it. It would be a rather drastic rearrangement but practical nevertheless.

The job of building the cabinet will be speeded and simplified no end, if you can borrow an ordinary ¼-inch electric drill with rotary saw attachment. Provided the blade is properly sharpened, it will have no difficulty in cutting any plywood or cleats that will be required.

Over and above this, you will need only ordinary bench tools, a serviceable vise and space to work.

Choose the sheet of plywood personally, making sure that it is flat, suitably figured without violent contrasts in colour and pattern, free from surface imperfections and, above all, well glued between layers. We used maple ply and, by cleaning bench and floor beforehand, made sure that it would not be disfigured during handling.

CUTTING THE SHEET

The accompanying diagram shows the suggested method of cutting up a 6ft. x 3ft sheet. The dimensions given are for the finished sections and allowance should be made for cutting and dressing. Use a hard, sharp pencil and an accurate T-square for marking out.

With a rotary saw it is possible to work almost to the pencil line by running the saw body or guide against a straight-edge clamped to the sheet Hardly any additional dressing of the edge should be required.

With hand tools, the same accuracy is not possible for an amateur and at least one-sixteenth inch should be allowed for dressing with a sharp finely set plane. Make each cut as accurate as you can, so that you will leave a reasonable edge for the adjacent panel.

When planing an edge, work from both ends towards the centre to avoid the risk of chipping corners.

Cut out the top of the cabinet first, choosing an original accurate edge for the front.

The two sides can be marked out next, as indicated.

The styling provides that the front edges be curved slightly inwards, to a depth of about ½-inch. We marked the rectangle first, then described an arc between the front corners by swinging the pencil at the end of a 90-inch length of cord.

Note that the sides are marked out with the concave surfaces opposite, so that the same side of the ply will ultimately be outwards in each case. Cut the two curves with a keyhole saw as the first operation, then cut the panels from the sheet. The straight surfaces can be dressed square but leave the finishing of the concave surface till later.

The bottom of the cabinet is made up from two narrower strips, in order to save the unbroken surfaces for positions where they will be seen — or needed. The two pieces can be cut out and the two mating surfaces dressed till they meet along their whole length. The edges which will ultimately butt against the sides of the cabinet should also be trued square, ready to assemble.

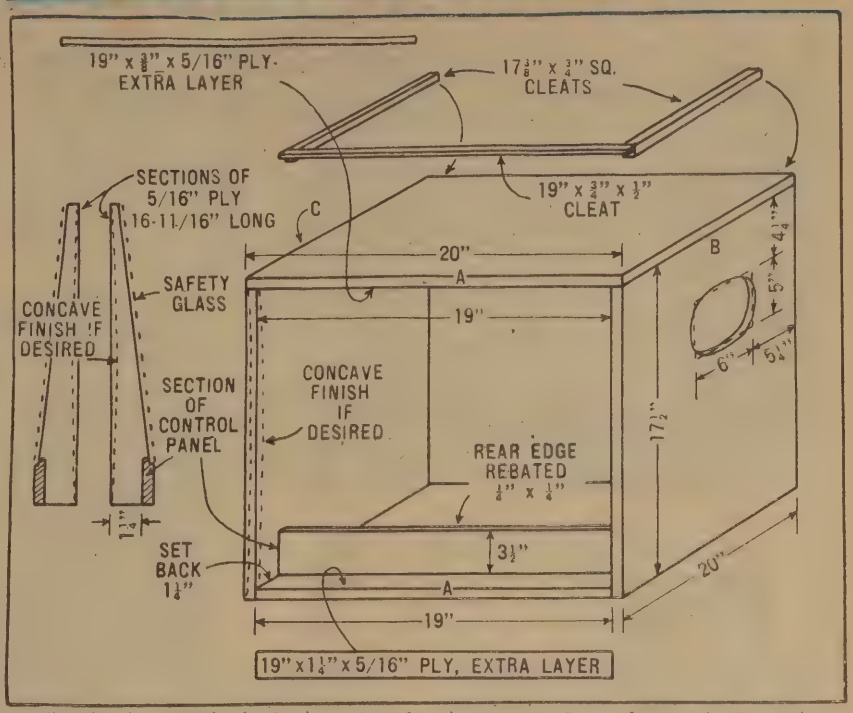
The edge which will ultimately face the rear of the cabinet should be inset for most of its length by about ¼-inch. This will accommodate and support a removable internally-fitting back for the cabinet, made from ¼-inch plywood or composition board.

At this stage, you will need some casein or other carpenter's glue and a couple of short lengths of 7/8-inch square, dressed stock for cleats to strengthen the butt joint between sides and top.

FITTING THE SIDES

Lay the cabinet top upside-down on the floor and stand each of the sides upon it, in turn. Line the sides up with the edge of the cabinet top, leaving a small margin for dressing, then mark along the inside with a sharp pencil.

BASIC DIMENSIONS OF CABINET



This sketch gives the basic dimensions for the cabinet. To conform with the modern styling, all corners should be finished square and sharp. The front edge of the cabinet and the edge of the speaker cutout should be filled and lacquered to provide contrast and to hide the laminations.

Cut the two cleats to length, drill three holes through them each way and countersink. Working to the pencil lines just marked, screw the cleats to the underside of the cabinet top, using screws which will drive well into the plywood without endangering the outer surface.

Note that the cleats stop about 1¼-inch short of the front of the cabinet. They also end ¼-inch inside the rear edge to provide top support points for the removable back already mentioned.

The sides can now be screwed into position, allowing the top panel to protrude at the front by the odd sixteenth-inch shown in the sheet cut-up diagram. The surplus will be dressed later to the contour of the vertical front edges.

Make sure that the top can be dressed square with the sides, that the sides tend to stand exactly vertical and that the butt joint is flush along the outer surface. If not, now is the time to correct any errors by judiciously planing the cleat.

by Neville Williams

Having checked on all these points, take the whole thing apart, coat all relevant surfaces with glue and screw tightly together.

The two sections of ply forming the bottom can be pinned together at this stage by dowelling, or by drilling fine holes in the centre ply and driving two or three 2-inch nails, minus their heads, halfway into each ply. Coat the edges with glue before you push them together.

See that the bottom section butts neatly between the sides. If all is well, coat the mating edges with glue, place in position and secure with half a dozen long panel pins through each side. Drive them at opposing oblique angles and punch the heads below the surface to allow for subsequent filling.

CONTROL PANEL

Next step is to make the small control panel, which should be squared and dressed to be a precise fit in the position indicated. Drill three holes through the bottom of the cabinet and countersink so that screws can be driven through into the bottom of the panel.

The top rear edge of the panel should be rebated ¼ x ¼-inch, forming a ledge to support the safety glass. Sand smooth, and round the front edge slightly.

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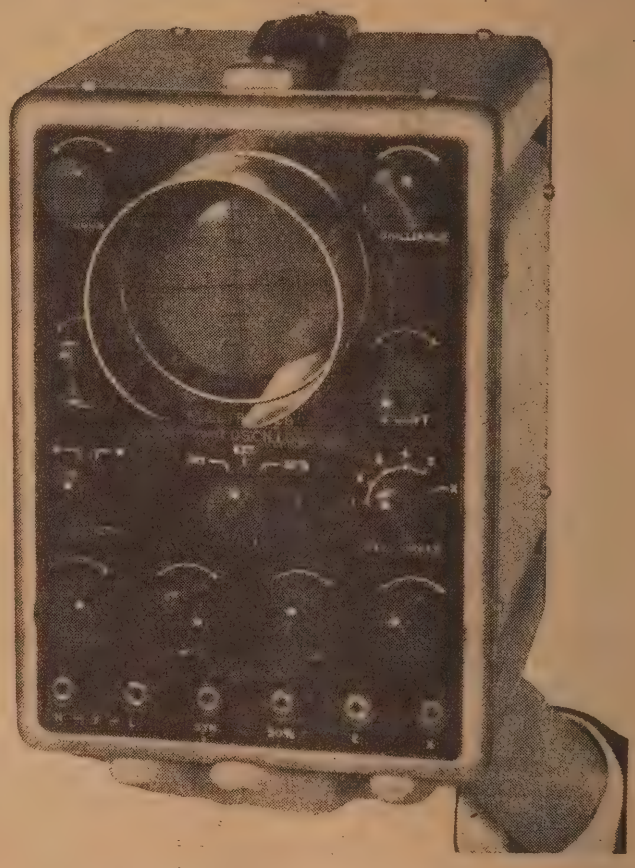

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This done, coat the bottom and sides with glue and push into position. Drive the screws through from the bottom and secure the ends with long panel pins, driven through the sides and punched below the surface.

The safety glass is intended to rest in the rebate just mentioned and behind an extra layer of plywood around the front edge of the cabinet. For this extra layer we suggest scraps of 5/16-inch ply. Half-inch ply may look too clumsy, while ¼-inch may not be sufficient to hide any inaccuracy in cutting the glass and mask.

First cut a strip of the ply to fit along the bottom edge of the cabinet, in front of the control panel. Cut it slightly oversize so that it can later be dressed flush with the bottom edge.

SIDE STRIPS

For the sides, two rather oddly shaped strips are required. The rear edge in each case, must form a line between the rebate in the control panel and a point no more than 3/8-inch behind the finished, dressed front of the cabinet top. This ensures a pronounced forward tilt for the safety glass, minimising reflection troubles when the set is in use.

Don't worry overmuch about the front surface of the extra strip, as it can be cut later to conform with the concave sides, using a coping saw.

Butt and pin the bottom strip to the side strips, paint with glue and pin the assembly to the cabinet front with short brads. Finally, add a narrow strip along the top, in line with the rear edge of the two sloping sides. You should now have a flat frame against which the safety glass can rest, and the exact dimensions required for the glass can be measured.

At this stage, pin-holes or other imperfections can be filled with putty or plastic wood and the cabinet put aside for the glue to set before finishing.

The safety glass is employed universally to protect the tube from the onlookers and the onlookers from the tube in case of accident.

Perspex sheet (or similar) is not recommended because it tends to scratch easily and may shatter under impact, particularly when cold.

TYPES OF GLASS

Ordinary plate glass could be just as dangerous as the glass of the tube envelope but heat-treated or "armoured" glass is often used. The main disadvantage is that it has to be cut before heat-treating and cannot be modified thereafter.

Probably the best choice for the home constructor is ordinary laminated safety glass, as used in windscreens of small cars. It can usually be obtained from glass merchants and cut to size on the spot.

By way of guidance, the safety glass in the prototype cabinet measured 13 5/8-inches by 18 7/8-inches.

When the glue has set, the cabinet can be dressed down ready for its final finish. Using a sharp, finely set plane, remove the overhang from the butt joints, keeping all corners strictly square. Be careful not to disfigure the surface layer on the two sides, the outer ply often being no more than one-sixteenth inch thick.

Plane from the outside towards the centre and see that the cabinet is supported against a suitable upright, so that the planing thrust will not fracture any glued joints.

The front edges of the cabinet should be dressed last, using a coping saw, plane and sanding block as necessary. The top and bottom edges should be inclined to continue the contour of the concave sides.

This done, the whole cabinet can be sanded smooth. If using a sanding disc in a drill, choose a fine grade of paper to avoid circular score marks, which can pick up wood stain in a painfully obvious fashion.

Before the cabinet can be surface-finished, one or more suitable cutouts have to be made for the speaker—or speakers.

Ideally, the proposed position for the speaker should be checked practically with the picture tube in its final position, and with a test pattern on the screen. Sliding the speaker in alongside it will soon show whether or not the strong magnetic field is going to distort the image.

Some slight reaction is inevitable, but mounting positions — or speakers—should be avoided which noticeably distort the pattern.

Using the type of speaker mentioned previously, an optimum position was indicated which would have brought the speaker cutout too low down on the side of the cabinet for a balanced appearance.

POSITION FOR SPEAKER

We compromised by placing the cut-out as shown, and mounting the speaker as low down as possible behind it, without actually uncovering the corners.

The cut-out shape resembles somewhat a picture-tube mask. While developed from a rectangle as shown, the corners were cut to a one-inch radius, while the sides were contoured to a thirteen-inch radius. The edges were kept sharp to match those at the front of the cabinet.

As mentioned earlier, the prototype cabinet has matching frets on either side, backed by gold-coloured expanded aluminium.

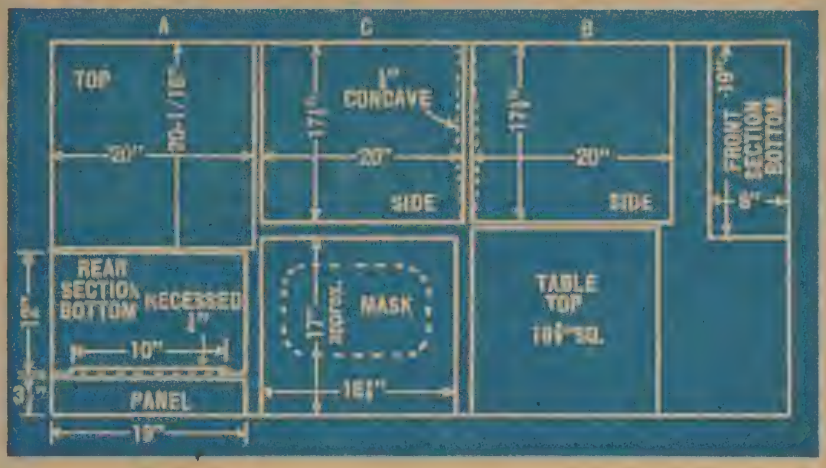
Actual finishing of the cabinet surface can well be the last job done on the receiver, but can logically be mentioned here. The preferred method will vary according to the ideas and aptitude of the individual constructor.

We used a method which gives a very acceptable result without requiring any special skill. From a paint store, we bought a small tin of oil stain of the appropriate color and applied one coat, using a pad of soft cloth. A pad spreads the stain far more evenly than a brush.

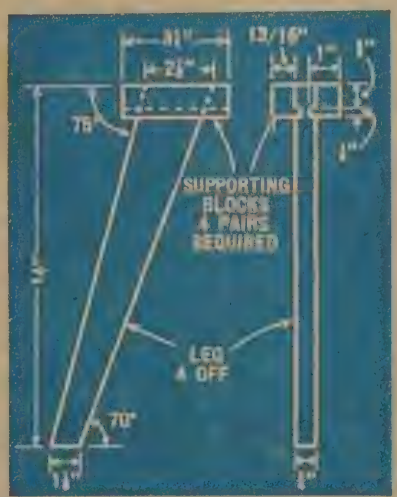
A second coat, applied next day, brought the wood to the required color density.

When this dried, the cabinet was given a first coat of clear brushing lacquer, care being taken to guard against

HOW TO CUT PLYWOOD SHEET



If you cut up your 6 x 3ft. plywood sheet according to this diagram, you will have enough to build the complete cabinet plus a table or swivel base on which to rest it. Cut the panels as you need them, marking the next panel from the new edge.



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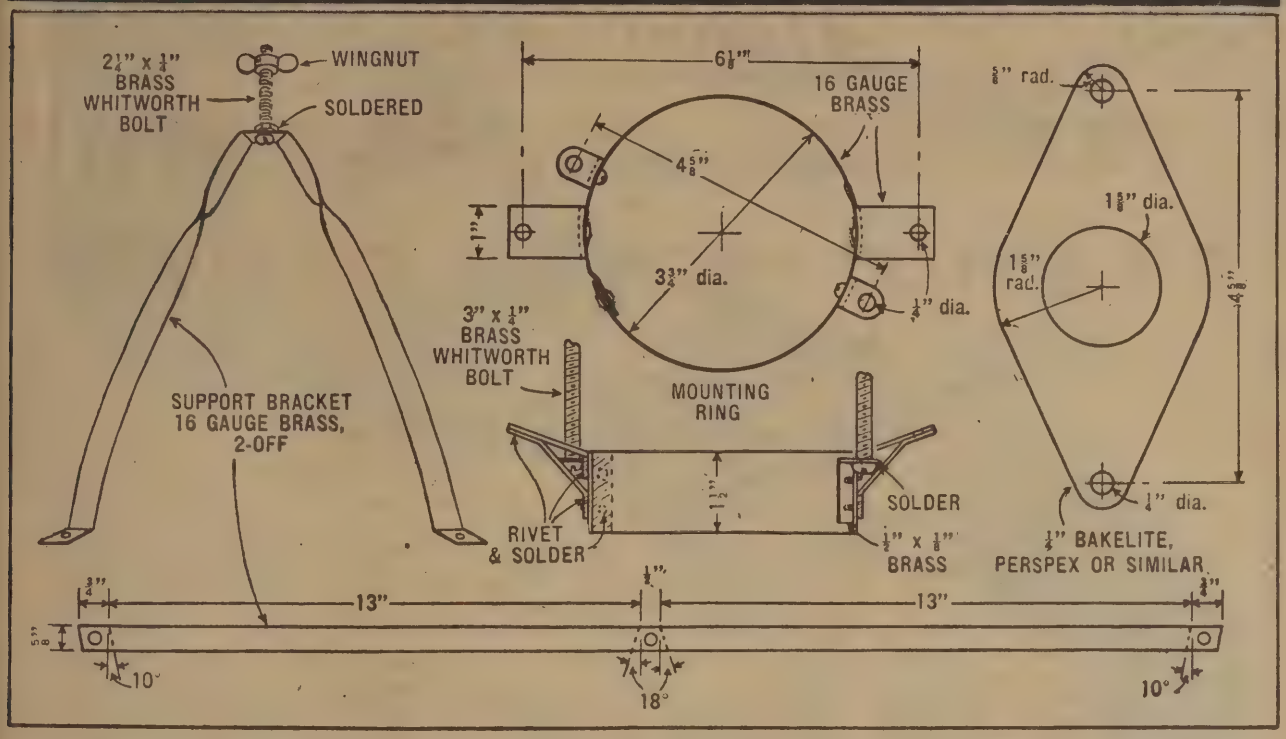

Brackets and locking ring, fabricated as shown will hold the picture tube and deflection yoke securely to the mask plate, which locks, in turn, into the cabinet. Again, no special tools are necessary to make up these parts. It is merely a matter of time and work.

dust and moths. The cabinet was in this condition when photographed, but the intention is to cut it back and apply a further coat (or coats) as necessary.

The front edges of the cabinet are best lacquered to hide the laminations. A milk-chocolate colour is a good choice for cabinets stained light to medium. For darker finishes use a deep chocolate or brown lacquer. The same lacquer can be applied around the inside of the speaker cutout.

MASK PLATE

So much for the cabinet finish. The last major item is the mask plate and assembly which supports the tube.

Of course, if you have already mounted the tube on the chassis, your task at this stage will not be very onerous. It will only be necessary to devise a few simple cleats to hold the safety glass in place, together with some kind of a mask. At the time of writing, commercially made masks are becoming available, needing only to be trimmed to size and locked in behind the safety glass.

The original design provides, however, for the mask, tube support and holding brackets to be assembled as a complete unit.

First step is to cut from the remaining ½in plywood the section marked for the mask plate. Trim it carefully so that it will push forward flat against the safety glass, making a neat but not tight fit against the four inner surfaces of the cabinet.

A ½ x 1in cleat should now be glued and screwed to the underside of the cabinet top in a position such that the mask plate will just wedge neatly between it and the safety glass, holding the latter firmly in position.

Since the thrust at the bottom is forward and down, with the tube in position, a couple of small angle-brackets bolted to the bottom corners of the mask plate and screwing to the sides of the cabinet will hold it firmly in place.

At this stage, the holes can well be drilled for the controls, through both mask and cabinet front.

Push the chassis into the cabinet, without the mask or glass in position and note where the shafts butt against the inside face of the control panel. Check for symmetry, then drill clearance holes for all shafts.

This done, remove the chassis, put the glass and mask plate in position and run a drill straight through the latter from the control holes in the front panel. The holes in the mask plate can then be enlarged further, to ensure ample clearance.

CUTOUT FOR SCREEN

Next step is to make the cutout for the tube face, in the position indicated, using a keyhole saw. The exact shape of this cut out can be derived, if desired, from the tubemaker's bulb-dimension diagram.

Alternatively, the exact shape of the tube can be obtained by resting it face down on the mask plate, on the floor, and marking around the shadow which the tube casts from a single light globe on the ceiling immediately above it. Then mark a new line about 3-8in inside the original and cut to this.

Note that the tube face should not pass through the mask but rests against the rear side of it.

Published data on the 17HP4-B indicates that the overall size of the envelope is 15-25/64 x 12-9/32, each dimension plus or minus 1/8 inch. The active screen limits, which would approximate the finished size of the mask opening, are 14-1/4 x 10-3/4 ins, both representing minimum dimensions.

Because the tube face is markedly convex, it will not rest flat against the mask plate. To build up the rear of the mask plate you will need some scraps of soft wood, such as redwood or Baltic pine, no less than 1 inch thick.

Cut these scraps so that they form a complete ring around the cutout. Roughen the underside and the rear surface of the ply, coat with good glue and place the scraps in position. Weight down and leave overnight to dry. Don't pin the pieces in position, because they have to be contoured later, and metal pins would greatly complicate the task.

When the glue is set, get to work with spokeshave, rasp and sandpaper, cutting away the surplus wood until the tube face fits snugly into position. Make sure, however, that the tube does not come forward sufficiently to protrude beyond the front surface of the mask plate.

With the rear surface properly contoured, the front can then be rounded and flared, but don't cut away the sides too much, as it will weaken the plywood mask plate.

FINISHING TOUCHES

Having worked the mask into an acceptable shape, it can be sanded down and a strip of felt glued to the rear surface, against which the tube face will ultimately rest.

Three chocks have to be attached to the back of the mask plate, one to either side of the bulb and one underneath, to hold it centrally in position. The chocks can be about three inches wide, protrude

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about the same amount and be contoured to match the bulb Cut them from a scrap of strong, close-grained wood and glue and screw them firmly in place.

To hold the tube forward against the mask plate and also to support the yoke, a few metal components will have to be fabricated. They can be made most easily by the home handyman from brass.

Begin by making up the two "V"-shaped straps shown in the diagram. A ¼ x 2-inch brass whitworth bolt should be passed through the apex of each, locked in place with a nut and sweated for extra strength.

EARTH CONNECTION

The "V" strap assembly provides a ready means of earthing the outer coating on the picture tube envelope. Rivet about a 3-inch leaf of spring brass to one of the V-straps (located on the side opposite to where the EHT connection will be), and bend so that it will bear against the tube envelope.

Later, by slipping a wire from the cable to the picture tube base underneath one of the holding nuts, the whole assembly plus the picture tube envelope can be earthed to the chassis.

The feet have to be bent over and drilled so that they can be anchored to four 3/16-inch bolts set in the mask plate Countersink the heads below the surface and lock the bolts in position with nuts, using a second nut and washer to secure the straps. Hide the bolt heads with plastic wood, along with the screws holding the chocks mentioned earlier and sand smooth

Later, when everything has shown to fit properly, the face of the mask can be primed, sanded and finished with a suitable flat finish paint Light colours ranging from a powder blue to a buff or ivory are a good choice, the last-named being a match for commercial ivory control knobs

Avoid dark colours, which tend to diminish the apparent size of a 17-inch screen

To surround the narrow portion of the bulb, you will need the ring assembly illustrated. This can be fabricated easily enough, using ordinary bench tools and a plumber's soldering iron

HOW TO MAKE

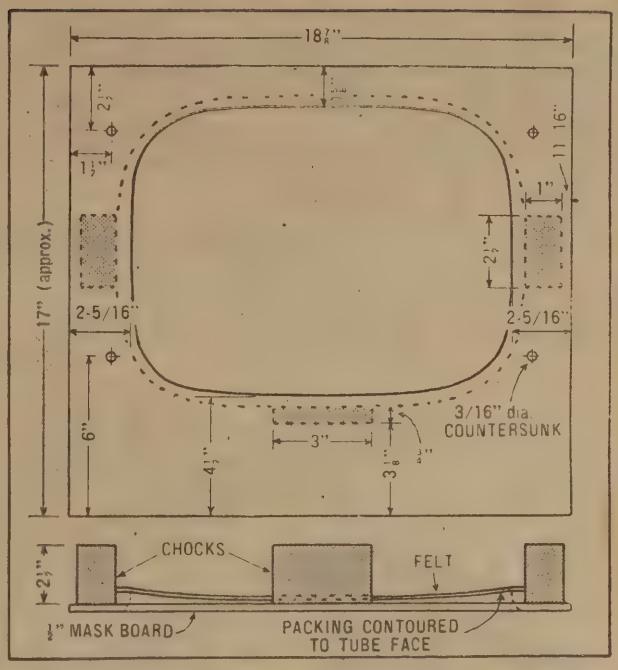
Cut the requisite strip of brass first, bend into a circle, lap the ends and secure with a couple of flush rivets.

Next step is to attach the two angled brackets which receive the bolts at the apex of the V straps mentioned earlier They can be made up from the same material as the ring.

Suggested procedure is to shape the rear section of each bracket first and attach to the ring by a single rivet. The front sections can then be formed and riveted in position, the sections being held together right at the tip by a further small rivet.

This done, the whole assembly can be warmed over a gas ring and all joints securely sweated, with the aid of a large soldering iron.

You will need a few inches of sponge rubber to act as a cushion between the edge of the tube locking ring and the glass envelope. We used a length of 1in x 1in rubber, obtained from an auto supply house. It was partially split along its length and slipped over the forward edge of the ring.



This diagram shows the position of the tube face cut-out in the mask plate The exact shape is best derived from manufacturers' tube dimension diagram or from the picture tube itself. If a commercial mask is used or the tube mounted on the chassis the screen would need to occupy the same position relative to the cabinet front

The two remaining small brackets are best made from 1-8in brass strip, heated and bent to a right angle. Pass 3in x ¼in Whitworth brass bolts through the short side and sweat in to position. Drill a couple of holes in the longer side and tap 1-8in Whitworth so that the brackets can be attached to the ring.

The final item is a simple flat disc of thick bakelite, plywood or perspex, shaped as shown. It slips over the two bolts just mentioned and locks the yoke against the picture tube neck

The accompanying photographs show the complete tube and mask assembly as it fits together inside the cabinet.

To assemble ready for operation, clean the safety glass thoroughly and push it into place, followed by the mask plate carrying the V brackets

Screw the expanded aluminium into place over the dummy speaker hole, followed by the aluminium and speaker on the opposite side Then push the picture tube up and into place, slipping the ring assembly over the neck and over the bolts terminating the V straps. Lock into position with wing nuts tightened firmly but not excessively

Complete metalwork for the R & H television receiver is readily available through trade supply houses, including chassis, EHT cage sub-chassis and brackets. For those who want to make their own, blueprints can be supplied from our office for 12/6 post free.

The tube should be mounted, by the way, with the E.H.T connection on the right, as you look into the rear of the cabinet.

The yoke goes into position next, with the leads coming out the underside. The bakelite plate goes behind this and is held in position with a further two wing nuts.

Two other items have to be added before the picture tube can be operated. The first is the centering magnet which slips on to the neck of the tube, narrow end first. Set the two levers close together to begin with and push it forward to about ¼in behind the yoke retaining plate.

The second item is the ion trap magnet, which is quite critical in its placement.

Slip it over the tube neck from the side so that the tiny magnet block is about in line with pin 12 on the base, with the red spot downward, adjacent to pins 9 and 10. It should be about ¼in to ⅜in from the bakelite base.

At this stage, the picture circuits are ready for their initial test. It is assumed that the receiver has already been in partial operation, receiving sound from the stations If you have been able to check the operation of the synch. separator and the two oscillators with the aid of a CRO—even an audio type CRO —so much the better

You may or may not have had the deflection output amplifiers in operation. As mentioned last month, these should not be operated unless the yoke is connected to form a load, though it does not necessarily have to be in position around the neck of the picture tube

SET CONTROLS

If the line and frame circuits have not already been synchronised by means of a CRO, set the Frame Hold potentiometer at half rotation and turn the Contrast and Brightness full off.

Screw the Line Hold control in till the adjusting screw protrudes about one half-inch from the base of the coil. Set the core of the Sine Wave oscillator coil about half-in, half-out of the winding.

Set the Horizontal Drive capacitor at about half adjustment, likewise the Height, Width and Linearity controls They will not remain at these settings for long, but it is more sensible to start from a centre setting than from either extreme.

The first job is to check on the presence of EHT for the picture tube. Connect the deflection yoke to the receiver, connect the earth wire from chassis to the picture tube coating and framework, but do not plug in the picture tube socket nor the EHT lead.

With an EHT voltmeter available, it would simply be a matter of measurement, but, in the absence of such an instrument, much cruder methods must be adopted. Let the lead dangle freely about an inch above the table top, with the metal connector exposed

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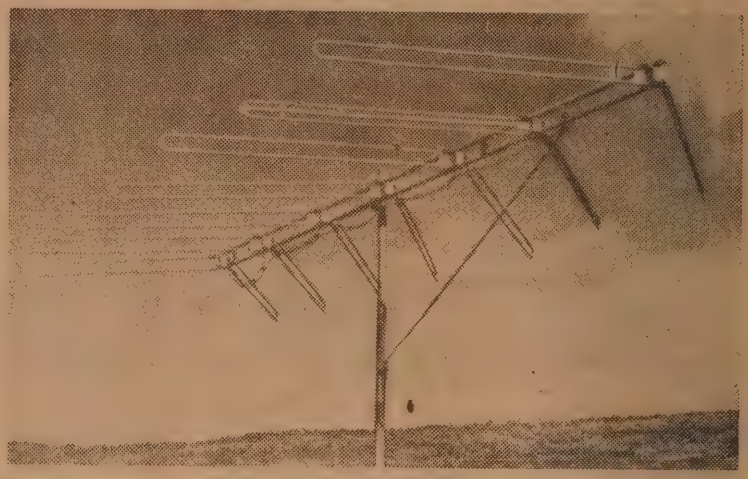

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Switch on and, about the time sound issues from the loudspeaker, you will probably hear and see a corona discharge from the connector. If not, earth one end of a multimeter lead and bring the prod gradually towards the metal tip. A single discharge or spark will be enough to indicate that the EHT circuit is working in a fashion. Don't play with if after that.

Switch the set off and use the same earthed multimeter lead to remove any charge from the circuit. Do likewise to the picture tube EHT nipple and connect the two together.

It is a good thing, by the way, to develop the habit early of discharging the EHT circuit before handling the wiring or the picture tube. The charge can linger for at least a full day and, while not directly dangerous, could conceivably cause one to mishandle a tube, with disastrous results.

Now plug the picture tube socket on to the base, prop up a mirror so you see the tube face and switch out all unnecessary room lights. Check to see that the Brightness pot is set for MINIMUM brightness and switch the set on.

DAMAGE TO TUBE?

The point behind this precaution is twofold. In the first place, no pattern at all may appear on the screen unless the ion trap magnet is close enough to optimum setting to direct the electron stream through the gun structure.

Secondly, in an attempt to obtain a pattern, the Brightness control may well be advanced to the limit, causing intense local heating where the misdirected electron stream strikes some portion of the gun structure. Some manufacturers claim that permanent damage can be done to the tube in this way.

By keeping the room illumination low, at first switch-on, it is possible to see the first trace of screen illumination and to move the ion trap magnet in the right direction for increased brightness.

It is not possible to predict a position for the Brightness control where a pattern should become visible because, apart from normal variation in component values, the beam current cut-off bias can vary widely with individual tubes of the same type.

The only direction one can give is to advance the Brightness control gradually until some illumination appears on the screen. If nothing is evident by the time a mid-setting has been reached, leave the control in this position and try a small movement of the ion trap magnet, moving it slightly fore and aft and slightly around the neck.

BRIGHTEST TRACE

If still no trace appears on the screen, advance the Brightness control and try again. The magnet should be set initially at the position which gives the brightest trace.

Normally, this should be some kind of a pattern spread over the whole screen. A bright line across the centre of the screen only would indicate that the line circuits are working and (incidentally) supplying EHT but that the frame circuit is inoperative.

In the event of this happening, reduce the brightness of the line to a workable minimum and check to see that the B-plus boost voltage is present. It should approximate 500 volts, as measured on an ordinary multimeter. Lack of this voltage or lack of vertical deflection with this voltage available would indicate a fault, which would have to be traced out.

Assuming all is in order, however, the pattern on the screen will probably be completely random and non-synchronised. Vary the fine tuning control till the pattern is most clearly defined—a setting which will not necessarily correspond with maximum sound volume.

VERTICAL LOCK

Now rotate the Frame Hold control till the pattern appears to stabilise, at least in the vertical direction. The locking action should be quite positive, the pattern holding over several degrees of rotation.

To lock the picture horizontally, vary the core setting in the Sine Wave coil, using a non-metallic screwdriver. At one extreme core setting, the picture simply fails to lock; at the other a form of motor-boating is likely to occur in the horizontal oscillator, producing a pattern of overlapping spiky lines, with an audible squeaking effect from the deflection components.

The locking position, somewhere in between these two limits, should once again be quite positive, giving you an obvious, if not optimum, picture. Having obtained it, various other adjustments can be made which will improve its quality and presentation.

A whitish line down the centre of the picture, about a half-inch wide, indicates that the horizontal drive to the line output valve is too high. Screw in the horizontal drive capacitor in the EHT cage until the line just disappears.

If no line is apparent, screw the drive control capacitor out until the line appears, then screw it in again till it just vanishes. At this setting, with the deflection components specified, the operating conditions for the EHT rectifier should automatically be at near optimum.

Next step is to re-check the setting of the ion trap. While set nominally for maximum brightness, the trap also has a vital effect on beam focus. The ion trap should therefore be checked against various settings of the Focus control until the line structure is sharply defined.

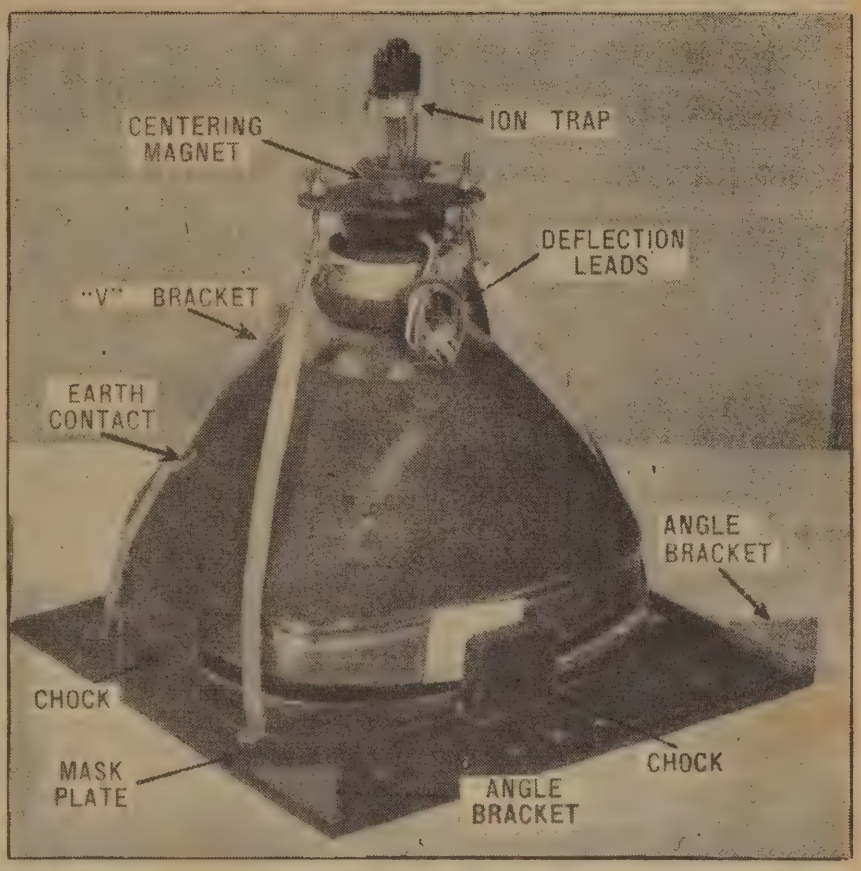
SHARP FOCUS

Whether you prefer to view the picture this way is another matter. The important point is that the tube is capable of very sharp focus over the whole area of the screen and the initial adjustment should aim at achieving it. Focus can easily be degraded later, if desired, by rotating the Focus control. This latter, by the way, is very broad in its adjustment.

By slackening the two rear wing nuts, the deflection yoke can be rotated bodily to ensure that horizontal and vertical lines in the picture are, in fact, so.

By following the manufacturer's diagrams, the picture should be correctly

TUBE MOUNTED ON MASK PLATE



A photograph of the complete picture tube and mask assembly, as it goes together inside the cabinet. The mask plate wedges up behind a cleat across the roof of the cabinet, while screws through the angle brackets in the foreground secure the bottom

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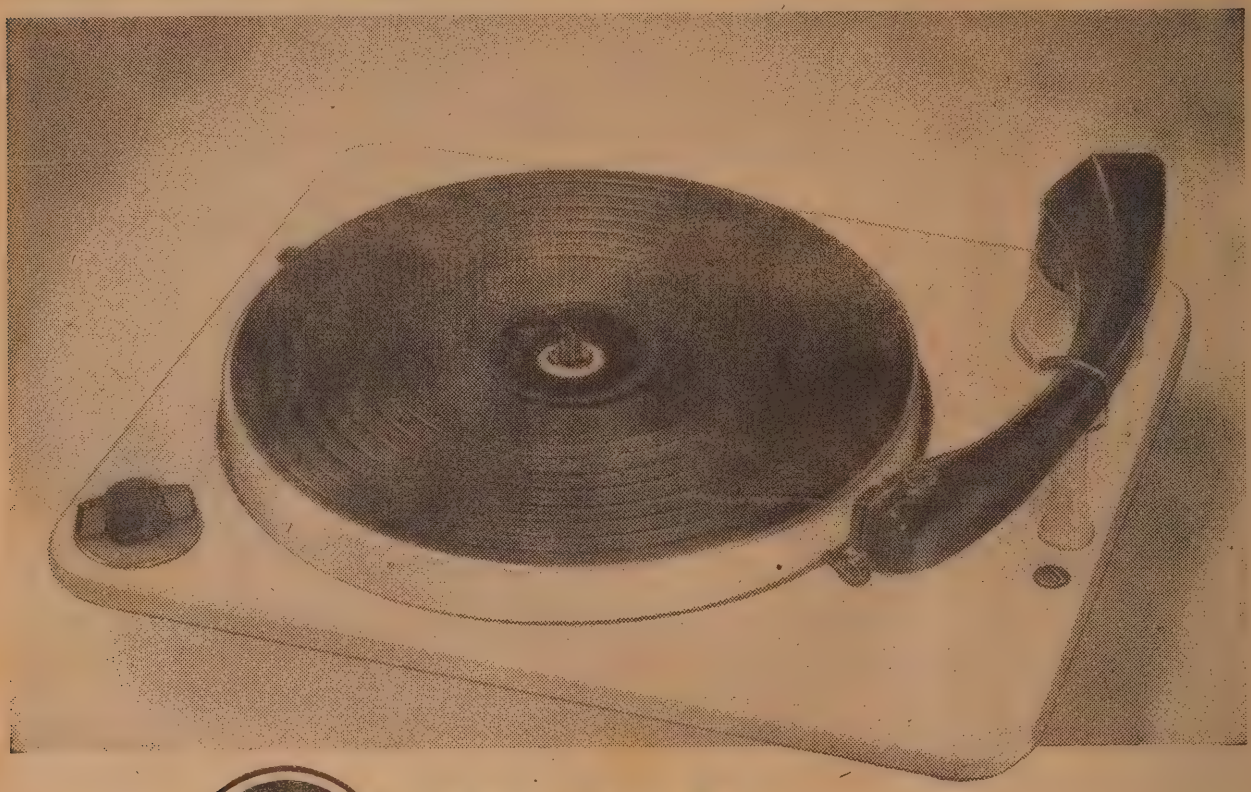

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presented. If, by chance, it is upside-down or transposed left-to-right, an error is indicated in the transformer-to-yoke wiring.

Don't try to correct it by swapping over leads at random. Certain windings within the yoke are shunted by damping components and the random reversal of leads can produce a picture which might be the right way round but suffering from "ringing" effects.

At this stage, the precise effect of the Fine Tuning, Contrast and Brightness controls can be observed.

Optimum settings for the last two are obvious enough and will vary with the ambient light and viewing conditions.

BRIGHTNESS CONTROL

The Brightness control should be set at a point which gives the impression that known white areas in the picture are white, without distressing glare or flicker. The sensation of flicker varies markedly with individual viewers but is always aggravated by having the Brightness control too far advanced.

The Contrast control largely determines the apparent density of the black areas. It should be set so that obvious blacks in the picture gives that visual impression. Too high a setting loses the deeper-grey tones, clothes most characters in black and produces a black blob on their heads in place of a properly high-lighted hairdo!

You will find also that the Fine Tuning control has a marked effect on picture quality. In one direction, the sound may become somewhat louder but the picture tends to develop halo effects and to lose its darker areas. Tuning further in the same direction first causes streaks to flash across the picture in time with the sound, beyond which the picture may disintegrate completely.

Tuning towards the limit in the other direction will retain the picture but result in a loss of fine detail. Simultaneously, the sound level may diminish and ultimately disappear.

HOW TO TUNE

The optimum tuning position is usually just clear of the region where sound streaks appear across the picture, at which point the sound level should be good, likewise the balance in the picture between dark areas, outlines and detail.

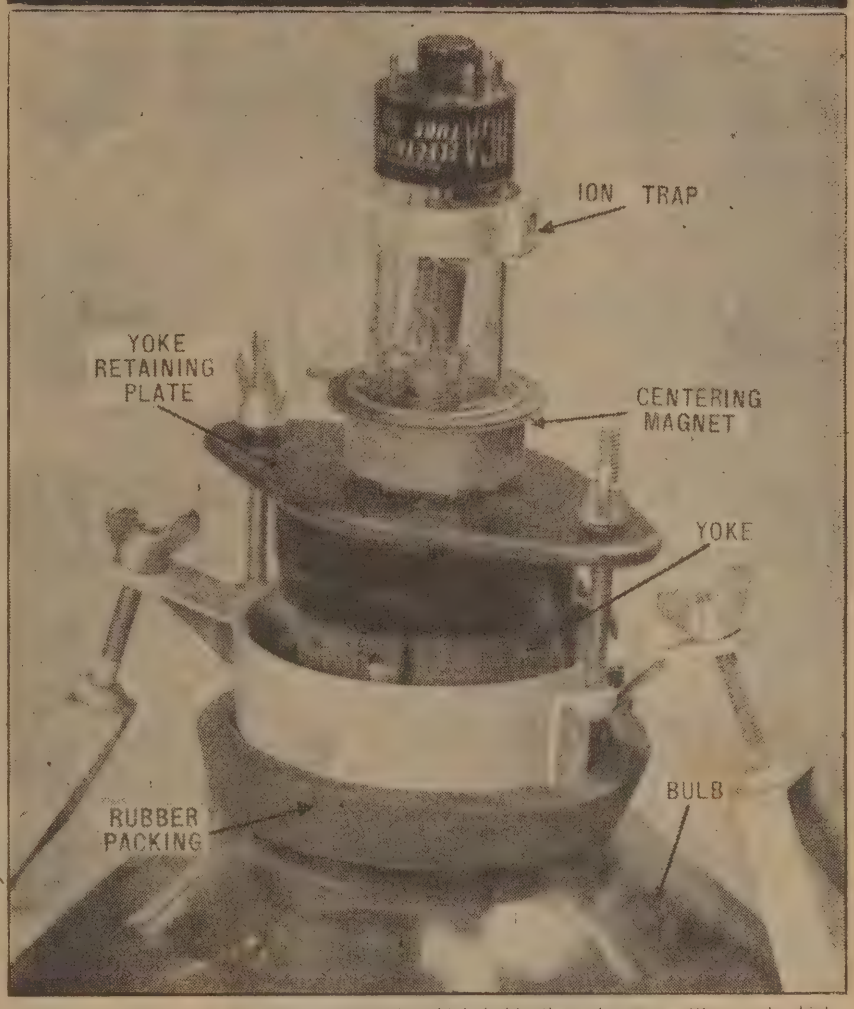
If this balance cannot be achieved, it can be accepted as prima facie evidence that all is not well with the overall pass band, or with the adjustment of the intercarrier sound channel. While that may be cause for concern in itself, it need not hold up preliminary adjustment of the picture. Merely tune for the best picture, irrespective of sound and proceed.

Adjustment of picture linearity and size is best done with a test pattern on the screen. These are available freely from local stations during the day or during periods preceding normal transmission.

The deflection components used in the original receiver are expressly designed, according to the manufacturer, to give a few per cent over-scan. This is to ensure that, with variation in components, line voltage, etc., the picture need never diminish below the size of the mask.

Screw out the width adjustment till as much of the picture content as possible is framed within the mask. If, of course, the picture can be narrowed to less than mask width, screw the adjustment in again till the picture occupies the full width of the mask opening with an additional small overlap at each end.

CLOSE-UP OF YOKE, TUBE CLAMP



A close-up view of the clamp assembly which holds the tube in position and which also clamps the yoke against the bulb flare. A spade clip at the end of an earth lead from the chassis can slip under one of the wing nuts, earthing the assembly and the outer tube coating.

VERTICAL ADJUSTMENTS

Now turn attention to the Vertical Linearity and Height controls. As we mentioned earlier, these are interdependent in their function and must be adjusted for best mutual effect.

You will find that the Linearity control tends to compress the top of the picture and open out the bottom as the amount of resistance in circuit is reduced. The Height control tends to open out the top of the picture more than the bottom, as the tapping is rotated toward the cathode end.

In practice, the best procedure is to set the Linearity control at about centre rotation and adjust the Height till the picture fills the screen, again with a small overlap. Observe the line structure and note whether the lines are more open in one region than another.

Now rotate the Linearity control by a few degrees, re-set the Height and re-check the line structure. If the linearity has improved, turned the Linearity control a few degrees further, readjust the height and check again. If the linearity has worsened, reverse the direction of adjustment.

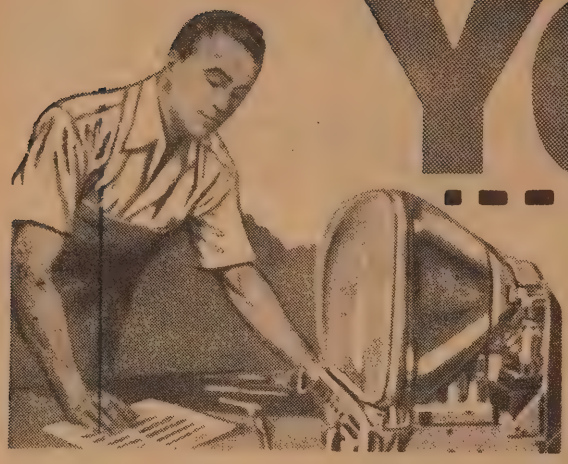
During the process you may become aware that the picture is off-centre on the screen and this calls for an adjustment of the centering magnet.

It is difficult to give precise directions about the way to do this, except to say that the magnet unit has the weakest total field when the levers are together, the strongest when they are diagonally opposite, with varying patterns when occupying intermediate positions.

TRIAL AND ERROR

The idea is simply to rotate the centering unit in its allotted position on the neck and with the levers in various relative positions. It should be possible to find a setting which centres the picture almost exactly on the screen.

After the initial run through, all these picture adjustments are best rechecked with a circle test pattern on the screen. It should be possible to get something very close to a true circle but beware



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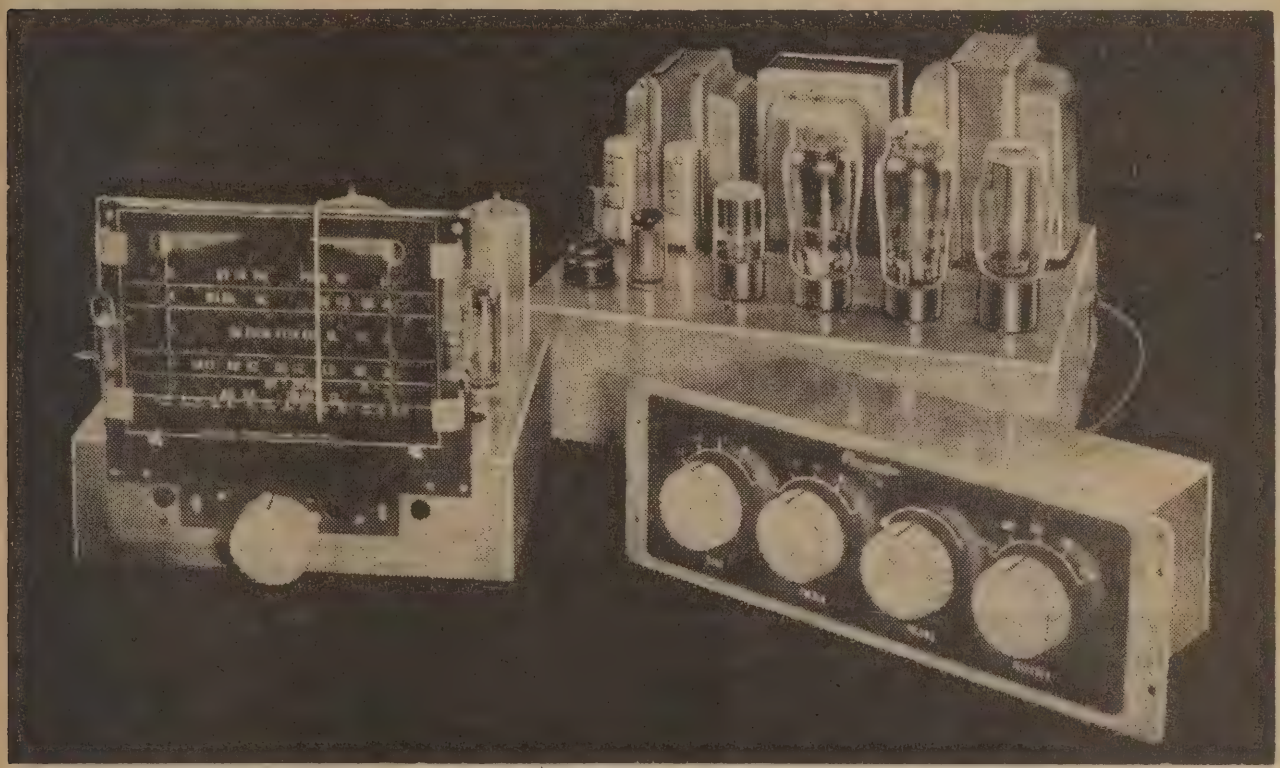

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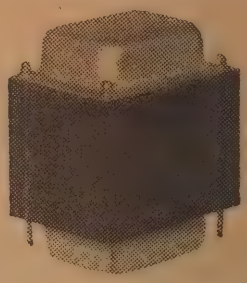

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of adjustments, which produce good linearity at the centre but which cause the top or bottom of the picture to open out sharply.

If compromise has to be made, which should be slight only, it is preferable to have a small non-linearity at the centre, which will not be noticed in an ordinary picture, than to have sudden elongation of heads and feet as figures move about the screen. This elongation effect can be most disconcerting.

The horizontal linearity in the original receiver was never a problem but the effect of the adjustment can be observed during these tests.

At this stage, it may be worthwhile to re-examine the setting of the Line Hold and Sine Wave coils.

If the core in the Sine Wave coil is screwed slowly in one direction from its normal "hold" position, an obscure "ringing" effect is noticeable, vertical lines becoming wavy.

ADJUSTMENT

Screwing the core away from this position gradually straightens the lines, then the whole picture is gradually moved sideways, with all vertical lines strictly straight. Further adjustment of the core in the same direction suddenly produces loss of synchronisation.

If the core is set too close to one extreme, vertical lines may show some curvature, though the picture will synchronise very easily. With setting towards the other extreme the oscillator may not synchronise immediately, when switched to a new Channel.

It is worthwhile to experiment with relative settings of the Line Hold control and Sine Wave core, to determine those which ensure immediate synchronisation without distortion of vertical lines.

For the sage of reference, the Hold controls never need touching in the original receiver and synchronisation is immediate, no matter how quickly the Channel selector is operated.

With the picture properly adjusted, the accuracy of the line interlace can be observed. You can do this by "playing tricks" with your eyes.

CHECKING INTERLACE

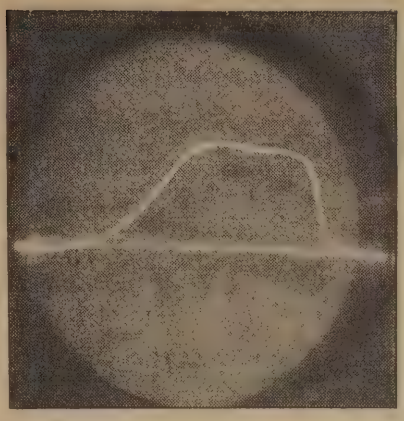
Look at the top of the screen carefully from about 15 inches away, then deliberately and slowly shift your gaze downwards, looking at the line structure as you do so. Your eye will suddenly seem to see the whole line structure gradually moving down the screen.

The same strobing effect can be obtained by moving the eyes upward from the bottom.

Then, by staring fixedly at a particular point in the picture and not allowing the eyes to wander, it should be possible to observe how the two sets of lines combine to cover the picture area.

With sharp focus and perfect interlace, only a faint darker streak should be visible between adjacent scanning lines. In practice, perfect interlace is difficult to obtain and the spacing between adjacent lines may not be exactly equal, though both should be discernable.

If the scanning lines are boldly apparent, with black spaces between them equal to the line width, and if the strobing effect previously mentioned cannot be observed, it can be assumed that the



Here is an unretouched photograph of the IF pass band characteristic of the original receiver. The 36Mc point is just perceptibly above halfway on the left-hand slope, while 31.5Mc is about 25% down on the right-hand side.

interlace is not operating at all and that the two sets of lines are pairing.

There is no basic reason why this should happen in the RT&H receiver, as far as circuit design is concerned. The one thing which will cause it above all others is a leakage of energy from the line deflection circuitry to the frame oscillator valve.

We have already stressed the importance of preventing this beneath the chassis, by suitable orientation of wiring and by the use of the small shield plate specified.

DEFLECTION LEADS

Above the chassis, trouble can follow if the deflection leads to the yoke are allowed to dangle near the frame oscillator valve. This can easily happen unnoticed, particularly when the chassis is finally installed in the cabinet. Keep the leads up out of the way.

Though not directly specified, the original chassis did have a shielded valve base around the vertical oscillator and the use of a can over this valve is a simple precautionary measure.

The remaining item which calls for special comment is the sound trap in the cathode circuit of the video amplifier. We must confess to another slight error in the circuit which was not specifically mentioned last month. The tuning capacitor across this trap should be .0022 mfd. as shown in the parts list, not .003 mfd as in the circuit.

The easy way to adjust the trap is to feed a 5.5Mc signal through a capacitor to the grid of the video amplifier, observing the output at the plate on a VTVM probe or wide-range CRO. Simply adjust the trap for minimum output as the trap passes through resonance.

In the absence of suitable test equipment, the trap can only be adjusted by observing its effect on the 5.5Mc component in the picture. If such a component is present, it will cause a very fine pattern along each line, not much longer in detail than the line is wide Adjust the trap until the pattern is least apparent.

Fitting the receiver in the cabinet calls for no special comment, most of the detail having been covered earlier in the article. The control knobs, however, require some explanation.

Both the Fine Tuning and the Brightness control have shafts larger than the normal quarter-inch diameter. In the original receiver, the Fine Tuning shaft is 5/16-inch and the Brightness shaft a trifle less.

CONTROL KNOBS

Standard 1 5/8-inch radio knobs can be opened out to the necessary dimensions with a blunt drill or a suitable file. Make them a tight push fit, so that reliance does not have to be placed on the grub screws.

This done, file the front of the knobs flat for a diameter of about ¾-inch.

Standard 1¼-inch knobs of the same type will serve as the band selector and volume controls, the latter bushed down to shaft size with a scrap of ¼-inch tube, split along its length.

One-inch knobs serve for the three minor controls in the centre positions.

The subject of television aerials, feeders, etc. has been covered in earlier in earlier issues (November, December, 1956) and does not call for further lengthy comment.

In average areas a fan-type aerial or equivalent should provide the right order of signal for the receiver in its present form, being well within the capacity of the simple A.G.C. system.

SIGNAL OVERLOAD

Close to the transmitters, the signal level from a large aerial may be excessive, especially on Channel 1. Excessive signal can cause excessive contrast, "negative" picture effects and haloes. In extreme cases, clipping of the synch. pulses in the IF channel can produce loss of synchronisation or tearing of the picture.

These remarks apply, of course, to any receiver using a simple A.G.C. system and indicate the desirability of using a more modest aerial in such a case.

Increased tolerance to high level signals can be achieved very simply in the RT&H circuit by eliminating the delay and clamp circuit from the tuner A.G.C. line, allowing the full A.G.C. voltage to be applied to the tuner at all times.

In the remaining space available, it is not possible to say very much about the i-allmportant matter of IF channel alignment. This whole subject will need to be covered in a future general article.

At the outset, we assumed that readers would purchase a completely aligned pre-fabricated IF strip and many, in fact, are doing this. Plenty of others, however, are buying the components and wiring their own.

Some are using "Q-Plus" components as in the original set and, provided the

(Continued on Page 121)

THE CIRCUIT

READERS are reminded that the circuit of this receiver appeared in the May issue and that certain minor corrections were listed in the June issue on page 64. Note that the sound trap tuning capacitor should be .0022mfd. not .003 as shown.

The 3,900-ohm 4-watt resistor shown in the parts list should read 3,300 ohms. For the Contrast control, use a full size 500-ohm carbon potentiometer. Cathode of the 6BQ6/6CU6 connects to pin 8.

Let's Buy An Argument

My reference, last month, to an "old-timer" was apparently a bit "close to the bone" for a reader in Sutherland, NSW. He reminds me of a fact which is only too evident, I'm afraid, to my barber, my dentist and my children. I—we—are all getting older.

by Neville Williams

OUR friend from Sutherland writes as follows, and I quote:

"Dear Sir,

"I notice your reference in the current issue to 'old-timers'. I hope it wasn't in ridicule, because the time mightn't be far distant when a new generation will refer to you in the same terms.

"Anyhow, I'm one of the 'old-timers' as you call them and I want to ask an old-timer's question. Why have they dropped grid caps again? I'm not disagreeing with the move, mind you, but it isn't so many years ago since we were fed with articles about why they were necessary. Something doesn't add up.

(W.P., Sutherland, NSW)."

First, let me assure W.P. that there was no thought of ridicule in using the term in question. Just the reverse, in fact.

If we really want to be rude to somebody in these columns, we usually manage to make it plainly obvious.

However, W.P.'s question is a good one and the position may look rather confusing from where he stands.

Back around 1930 and beyond, valve electrodes were all brought out to base pins, which were easy to remember and easy to wire.

Then, all of a sudden, top cap connections appeared and they were a confounded nuisance. They called for trailing leads out the top of coil cans and IF transformers. They called for clips, which either fell off the top-cap or else stuck so hard that you pulled the cap adrift from the glass, trying to separate them.

SHORT TO CAN

Alternatively, they would short intermittently to the top of the valve can, particularly with valves which happened to be a bit longer than average.

For the unsuspecting, there were caps which connected to plate instead of to grid and which therefore carried the full high tension voltage. A lovely handful, indeed.

Then, just when we'd all got used to these things and accepted the arguments as to why they were necessary, along came new valves without top caps. Better valves, mind you.

Why couldn't they have done this in the first place and saved a whole era of worry and service calls?

I must admit that, on the surface, it looks anything but consistent, but, actually, there's a very simple and practical story behind it. It's quite certain that valve manufacturers didn't put caps on the top because they enjoyed doing so. Arguments over loose top-caps and over-long valve envelopes weren't good for business. They just didn't know a better answer at the time.

THE VALVE STORY

The story has been told in other places at other times but, since the question has been raised again, it will probably bear repeating in outline, at least.

As was only to be expected, early valve manufacturing techniques were borrowed freely from the lamp making industry and the most notable heritage was the "pinch" type of construction. It is illustrated on the left in the accompanying diagram

Connecting leads were brought up through a skirted tube, whose top was heated and compressed to hold them firmly in place. The leads were then trimmed and bent on a jig to suit the particular valve.

The pinch also carried an exhaust tube to permit ultimate evacuation of the glass bulb.

Operators then welded grids and plate to the support wires until the complete electrode structure was built up. This done, the pinch assembly was put into an automatic machine, which sealed a glass envelope over the top, completely enclosing it.

Next stage in the manufacture, also carried out on automatic machines, involved extracting the air from the bulb and firing the "getter". Then the base was added, the cathode heated and aged and the characteristics checked.

This general technique, with variations, was used almost universally for many years. It suffered a major disadvantage, however, in that leads from the actual electrode structure, down through the pinch to the base pins were inevitably two inches or more in length. They, therefore, had a definite and inescapable capacitance one to the other.

This didn't matter much with ordinary triodes or audio amplifiers, but it did matter when RF tetrodes and pentodes were introduced to overcome the problems of grid-plate feedback.

It was plainly futile to introduce a screen into the electrode structure to minimise grid-plate capacitance there, but do nothing to reduce capacitance between relevant leads inside the pinch base and socket.

Since there was no easy way of shortening the leads, or of moving them further apart or shielding them one from the other, the only resource was to bring either plate or grid out the top of the envelope. Hence the practice of doing so.

INDUCTANCE PROBLEM

Valves might still have been made that way, had it not been for the fact that increasing use of the higher frequency bands also made it essential to reduce the length—and therefore the inductance—of all internal leads. New manufacturing techniques simply had to be found.

One of the most significant advances was the development of metal valves, as illustrated. In these, the pinch type of construction was abandoned and electrode support wires passed straight up from the base pins, through glass beads in the bottom of the envelope.

This construction greatly reduced the length and inductance of the leads and also made it possible to reduce the effective capacitance between any two of them by placing them on opposite sides of the base, with the metal exhaust tip and other "earthy" electrode pins between them.

By careful planning and placement it, therefore, became possible to make successful "single-ended" RF pentodes.

Though metal valves were not a commercial success for other reasons, the lessons learned in their development were not lost. Having broken away from the traditional "pinch" techniques, manufacturers applied them to the development of modern all-glass miniatures.

The construction of a modern miniature is illustrated at the right and the difference from the old pinch-type construction is immediately apparent. There is no separate base and no bulky base pins—just wires which come straight up through the bottom of the glass envelope.

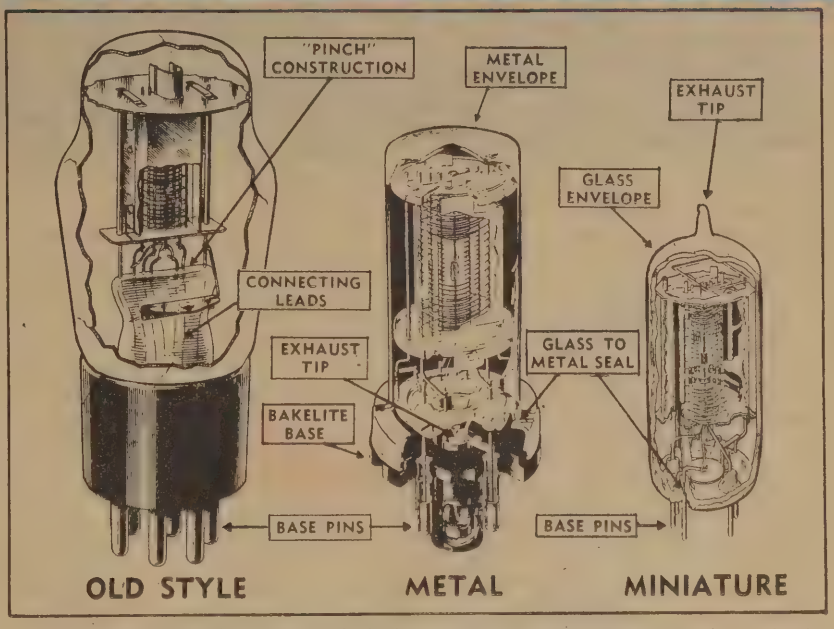
SERVE AS PINS

At one end they act as pins. At the other, they are bent over and provide support for the electrode structure. Incidentally support points around the circumference of a circle make for a much more rigid assembly than support wires in a straight line.

The important point is, however, that the leads are comparatively short, making for low inductance. And because they are short and well spaced, it is possible to interpose shield vanes and other "earthy" leads between grid and plate, thus keeping the effective capacitance to a small figure.

In the socket, too, an earthed-metal centre spigot shields grid from plate, and it is incumbent on the set builder to keep the relevant leads well apart. Forget to earth the spigot and a high frequency amplifier stage will oscillate like a champion.

WHY NO TOP-CAPS ON VALVES?



A reader from Sutherland, NSW, thinks he can see an inconsistency in valve makers' ideas during the past twenty years. Valves were originally single-ended, then they sprouted top-caps for a while. Now they are back to single-ended.

But I think the point should be clear, W.P. The single-ended construction is now only possible because of a completely new approach to assembly, sealing and basing.

Why didn't they do it back in nineteen-thirty something? Simply because thinking and techniques hadn't advanced that far.

Put yourself in the position of a factory chief who has a building full of expensive automatic machinery based on the bulb, pinch and bakelite base techniques. He can produce an RF pentode by the expedient of providing a metal top cap.

THE "UNKNOWN"

The alternative is some as yet untried technique of sealing metal pins into a glass button base, building an electrode structure on to it, then welding it to a glass bulb, without the whole thing dissolving into a molten mass in the process.

Even assuming it to be practical, he has no machines to cope with such a technique on a mass-production basis. To develop and build them would cost a fortune, not to mention the many other machines necessary to produce the special "bits" which would be needed for the new valves.

What would you do?

Of course you would.

And that's the way it is with so many new things. They're not suddenly invented, but grow out of techniques developed over many years.

To change the subject, our worthy friend "The Serviceman" dumped a letter on my table the other day, which had originally been addressed to him via this office.

"You buy all the arguments around the place," quoth he. "Have a go at that one."

"That one" was a letter from R.F.C., in Launceston, taking the serviceman to task for one of his statements. The letter is reproduced in precis form over the page.

As you can see, our friend can't understand the statement that the mere substitution of a better speaker can make any worthwhile difference to the reproduction from a mantel set. His idea is that you should start at the other end, building a good amplifier first and making do with the best speaker you can afford.

Well, I can't entirely condemn either R.F.C. or the serviceman's friend for their points of view, for they are both half right.

It's rather akin to an argument which I heard recently in other circles about what one should look for in buying a second-hand car. One maintained that a good engine and gearbox was fundamental, the bodywork being a secondary matter. The other party maintained that bodywork and upholstery could never be restored, once ruined, but an engine and gearbox could.

POINT OF VIEW

The only thing obvious from such an argument was that both were willing to compromise and that both of them would be better off than a man who bought a car having a bad engine and bad bodywork as well.

In just the same way, the quest for good sound demands attention to both the amplifier and the ancillary equipment. To provide either one without the other is to do only half the job.

But that doesn't say that an improvement anywhere in the system won't be noticeable or worthwhile. If any proof of that is required, I need only refer to our current television receiver.

There's nothing pretentious about the audio amplifier or the speaker either, but I've lost count of the number of people who have commented on the sound quality.

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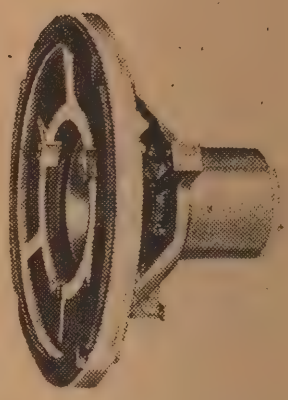

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Why?

Well, apparently because the 8in speaker in a wooden cabinet is a cut above the usual mantel set. In addition, it has a small amount of built-in bass boost and the advantage of a clean FM signal input.

In just the same way, RFC's amplifier will undoubtedly deliver a more liberal and better-balanced signal than the commercial radiogram, with the inevitable result that it sounds better.

But don't lose sight, either, of what our serviceman's friend accomplished by using a large, well-baffled speaker with a good quality output transformer.

He would have recovered a whole realm of bass response and some of the treble, which must have been missing from the small output transformer and former small speaker.

SOME IMPROVEMENT

He must have reduced the total distortion by whatever margin of merit the large speaker had over the small one. Furthermore, because the larger speaker would almost certainly have been more sensitive, he would obtain the required output with the amplifier operating at lower level and probably lower distortion.

If all that didn't add up to a noticeable improvement, I'd be very surprised. I agree, however, that he might have realised nearly as much improvement at considerably less cost by using a large speaker of more modest design, properly fed and baffled.

From past experience in these matters, I'd say that the greatest danger in adding a high quality speaker to a poor receiver or amplifier is that it will make audible gross distortion which might be present.

Things like inadequate AVC, a badly designed detector circuit, or a faulty coupling capacitor can cause distortion which can be most distressing through a wide-range speaker system. But then I assume that our serviceman's friend would have made sure that the set was working properly before he went to the trouble of adding the transformer and speaker.

CORE TROUBLES

My remarks recently about troubles with iron cores were apparently read and approved.

There was also a certain sympathetic support for my grouch about the troubles caused by the iron-core adjustments in coils and IF transformers.

It is quite obvious that many readers have suffered precisely the same annoyances as those listed. Nor has the process finished. The spate of activity brought on by television set building has meant that more people are discovering for themselves the nasty little habits of iron cores.

In a typical strip with 16 cores, 15 of them might work like a charm. It's that inevitable odd one that causes all the bother. It jams, or breaks, or slops about in the most exasperating fashion.

A reader from Mount Waverley, Vic., offers his own "solution" to the problem. The pun is his, not mine. It is in the use of beeswax.

Quite frankly, I frowned somewhat at his opening sentence, much as W.P. must have done at my use of "old-timer."

Then I realised that the word "beef" had a purely accidental connection with another Australian colloquialism, which isn't quite so complimentary.

As to whether beeswax is better than any other wax for sealing cores, I'm not sure. E.B. thinks it is. You may think otherwise.

I'm not even sure about its being readily available. It may be in Mount Waverley and it certainly was on the mixed farm where I spent some of my youth. But in the wilderness of George St. or Collins St. it may be a completely unknown commodity.

One day last week, for example, I was fiddling with the IF channel in a receiver, the brand of which had best remain unmentioned. All went well till I went to touch up the slug in the ratio detector transformer, the very last in the line and the most important.

It moved a couple of turns, then stuck fast.

VARIOUS METHODS

I coaxed it, talked nicely to it, tapped it, tried a little gentle persuasion, then a modest show of force, all to no avail. I removed the bottom slug and tried a tool top and bottom but, no, it refused to budge.

By that time, the cardboard former had loosened from the end mouldings and one of the internal wires had broken. The transformer had to come right out, the core had to be cracked and chipped away, the winding repaired and then the whole thing soldered back again.

That kind of thing is enough to try the patience of anybody, especially a serviceman, whose livelihood and good name is ticking away while he fiddles! Of course he can get a new transformer but, unless he has a wife and family who love making special trips into the city, the customer has to wait around until the replacement permeates through the postal system.

It just shouldn't happen!

ONLY REAL DANGER?

Personally, and with all due modesty, I feel that the only proper answer to the problem is the one I suggested some months ago — a little plastic thing like a flat-headed nail but with a hexagonal shank to fit through the cores.

After alignment, you would push it down through the cores, seal it to the top of the can and forget your troubles.

In most cases, the cores could be "wangled" enough to let the shank pass straight through, without upsetting the effective alignment. If not, the shank could be clipped off and two of them used, one from the bottom and one from the top.

One reader, commenting on the idea, suggested alternatively that the head of the thing could be moulded flat, in line with the shank but split so that it could be pushed down and sprung into the actual former.

I think that something like this will be inevitable but it just awaits somebody with sufficient time and energy to organise the die for the job.

In the meantime, here's another thought that might lead somewhere. This one was born, in a sense, of necessity.

I was fiddling around at home with a device which was suffering from the malady known as "sloppycoritis" and

(Continued on Page 121)

ARGUMENT FOR "THE SERVICEMAN"

Dear Mr. Serviceman,

I am a constant reader of your articles, which I usually find most interesting. But I am afraid I spotted something in this month's issue which brought me out of my complacency. It was the bit describing how a colleague had hum trouble caused through coupling with an electric clock.

Well that part of it I found most interesting but how on earth does he prove that a good quality speaker will make most of the difference to producing good quality sound?

Did he imagine a great deal? Was it because his original speaker was small or old? Was it because it was mounted in a bakelite cabinet, which is poor at any time?

My argument is that it is not possible to get near to perfect sound reproduction from an expensive speaker using only a mediocre single-ended amplifier. Obviously, the best speaker in the world can't get rid of distortion which such an amplifier introduces.

To bear up my argument, I have just completed the amplifier using two 6BM8's as described in a recent issue of R, T & H. Using only a cheap output transformer and a modest Rola 8-0 speaker, the difference compared with our commercial radiogram is the difference between night and day.

(R.F.C., Launceston, Tas.)

THOSE COIL SLUGS

Dear Sir.

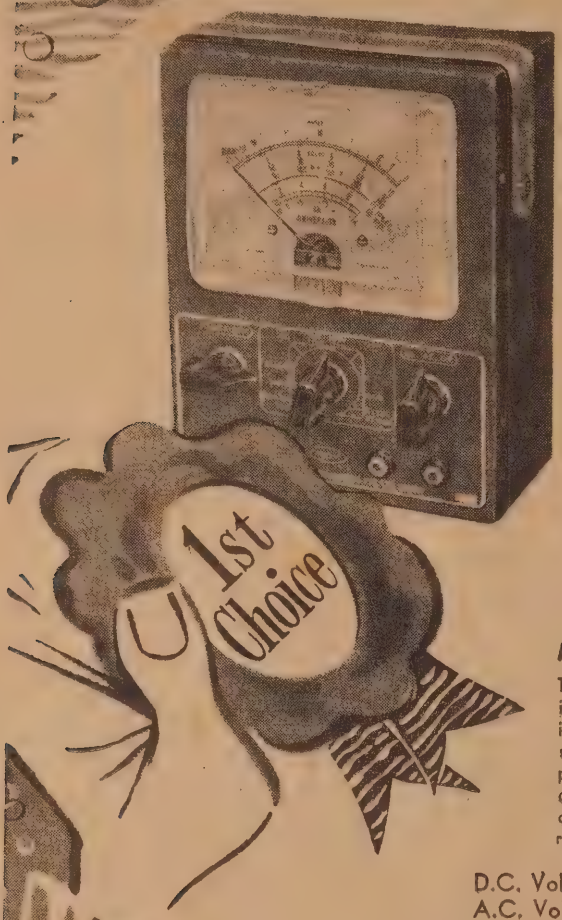
I read recently your "beef" on the subject of pesky coil adjusting slugs and I'd like, if I may, to offer my "solution" to the problem. Compared with your suggestion of the hexagonal rods, which gets right to the root of the problem, mine is only a treatment of the abovementioned type of slug.

To get down to it, I seal the slugs with beeswax which, I think you'll agree, is quite easily come by. Beeswax has a fairly high melting point (64 degrees C.) but I think more important is its tenacity combined with a certain amount of plasticity at normal temperatures.

I've found that it holds slugs quite firmly but still allows you to carry out further adjustments without having to melt it away. Adjustments done, a touch with the soldering iron remelts the wax, which is then allowed to cool in its own time.

If you happen to put too much on at first and cover the whole slug, a sharp knife will pare away the excess.

(E.B., Mt. Waverley, Vic.)



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DO AMPLIFIERS SOUND DIFFERENT?

Recently the opinion that the loudspeaker is the weakest link in the reproducing system and that amplifiers have progressed about as far toward perfection as it is possible to go has been widely expressed. As a basis for this conclusion, it is stated that the residual degree of various kinds of distortion present in modern amplifiers is so small as to be impossible to hear. However, many are not yet satisfied that this philosophy is true.

By NORMAN CROWHURST

TO illustrate this view, the following experience is by no means impossible or uncommon: two different amplifiers are compared, using the same pick-up or tuner as a program source and the same loudspeaker. Both amplifiers, although of different design, use the same input and output impedances, provide the same damping factor for the loudspeaker, and give frequency responses and degrees of distortion which deviate by an acknowledged imperceptible amount — yet any discriminating listener can discern quite an appreciable difference between the sound of program played through the two amplifiers.

DIFFERENCE IN SOUND

For example, a trumpet recording is played through the two amplifiers and on one sounds quite clean while on the other there is a definite harshness about the reproduction. When the gain control is turned back the harshness becomes less noticeable, but only because the level is that much lower — it does not disappear completely, as one would expect if it were due to clipping, or an overload effect.

It became quite evident that something happens inside some amplifiers that is not adequately covered by the specifications. Incidentally, the amplifiers were checked on the same measuring equipment and both found to conform to their published specifications, which ruled out the possibility that one was not as good as it claimed.

Some work the author has been doing recently has verified two possible contributing causes for this kind of difference. From the result of these experiments it seems quite possible for an amplifier to perform to extremely close limits under standard test measurements and yet, with program material, the same amplifier can produce temporary or transient distortion conditions that are loud enough to be perceptible. Both these transient conditions are related to the nature of the roll-off characteristic produced by the feedback.

It is well known that, when you apply more and more feedback to an amplifier, a condition is eventually reached where the amplifier becomes unstable. This is due to the fact that, at some frequency, usually below or above the audio spectrum, the feedback becomes positive and causes oscillation. The frequency of this oscillation may be down in the region of 1 or 2 cycles or up in the region of 100 or 200 kilocycles, depending principally on which happens first.

Normally, of course, amplifiers are operated with considerably less than this amount of feedback, so they do not oscillate. Naturally, one would think that a margin of 2 to 1, or a little more, in this direction would be satisfactory to insure that the amplifier could not get unstable under any conditions. Many amplifiers have been designed with about this much margin.

EMERGENCE OF PEAK

This, however, overlooks certain fundamental facts that evolve from a mathematical consideration of feedback design. As this article is not written primarily for engineers, we shall refrain from going into the mathematics of such design. It is fairly easy to understand that, as we increase feedback, before the amplifier starts to oscillate, it will show a peak in the response, in the region of the frequency where it will eventually oscillate. The question is: how much must the feedback be reduced, below the amount which causes oscillation, before the peak is completely removed?

This is where the mathematics help some: in average amplifier design, we learn that the margin between oscillation and peaking, at the low-frequency end, is in the region of 18 db; while at the high-frequency end, it will be in the region of 12 to 14 db. These figures represent ratios of 8 to 1 and 4 or 5 to 1 respectively, both of which are considerably larger than the previously suggested margin of a little more than 2 to 1. These facts are illustrated in Fig. 1.

In comparatively recent times, the importance of an adequate margin at the high-frequency end has been realised. This was shown up at first by the use of square-wave testing. If there is any peaking in the amplifier response, or if the roll-off is too sharp, this will show up on a square-wave test as ringing at the corners of the square wave, as shown in Fig. 3.

ANTI-RINGING CIRCUITS

Many amplifier designers have, accordingly, paid attention to this feature and made adjustments to the amplifier so as to prevent this ringing. This means that high-frequency peaking must be absent from the amplifier.

However, there may not be the full 12 to 14 db stability margin, because the designers have used a trick to produce a satisfactory square wave: phase-shift capacitors associated with the feedback circuit. It's true that this method produces perfect amplification of the high-frequency end, for transients as well as steady tone, when the amplifier is connected to a resistance load.

Sometimes the designer has been careful to make sure that the amplifier performs reasonably well into a reactive load, but to make this test he uses for his reactance a capacitance across the output.

What seems to have been overlooked is the fact that most people use dynamic loudspeakers (woofers, squawkers, and tweeters) whose impedance becomes that of an inductance at the high-frequency end—and an inductance that

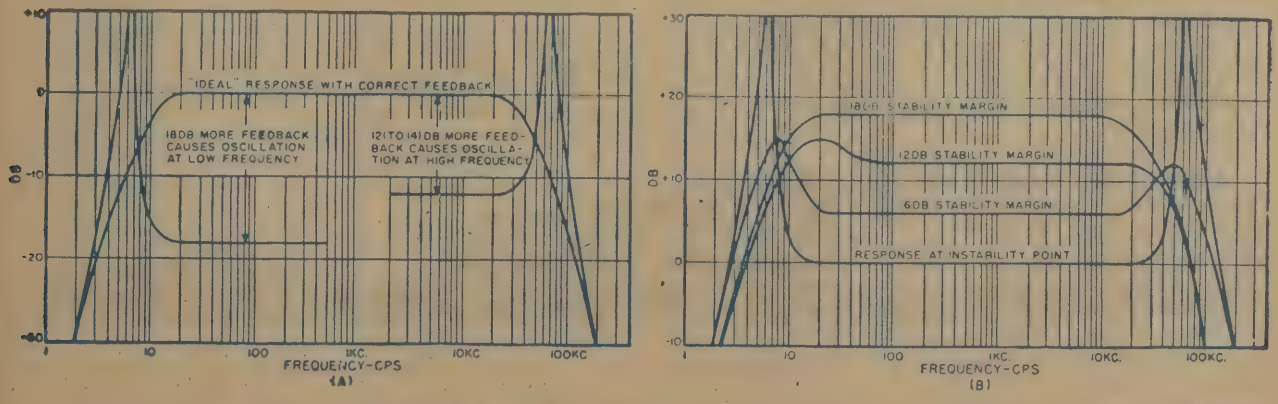

Fig. 1: (A) Ideal response when the feedback is correct; part curves show instability points as feedback is increased. (B) Effects of various stability margins on the over-all response; 12 db is proper for high end and 18 db for low end.

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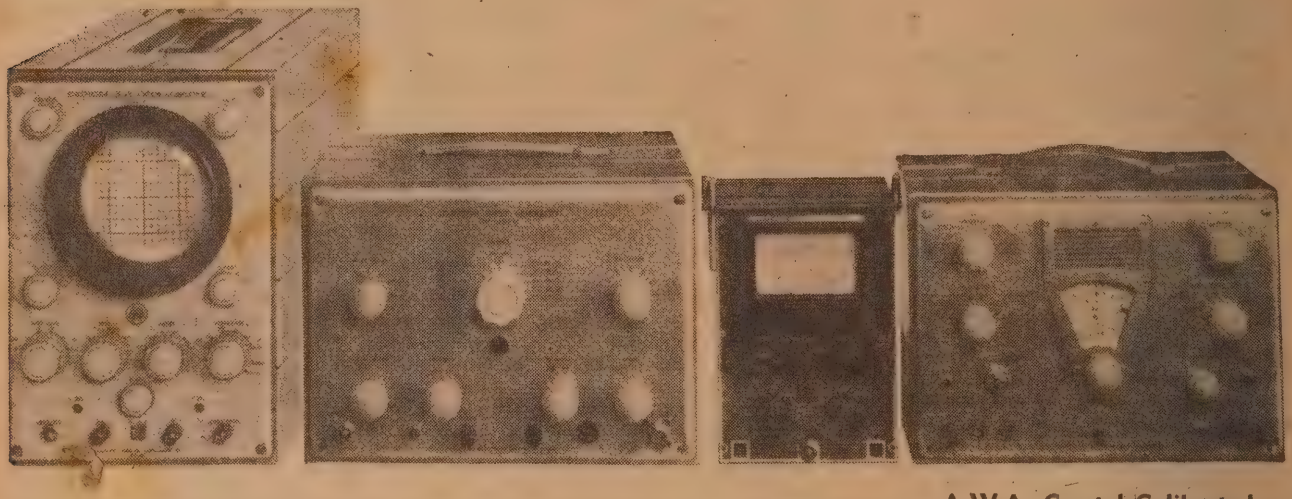

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gives a reactance somewhat larger than the nominal voice-coil resistance.

This means that the amplifier loading is quite different from the conditions under which it is tested, as shown in Fig. 2.

The nature of the "finagle" used can be seen by a glance at the schematic: it has at least a "phase correction" capacitor across the feedback resistor, and probably has several other small-value capacitors (values given in uufd, not ufd) at various points in the circuit.

This produces a satisfactory response with less than the basic 12-14 db margin, but because of this the arrangement is inevitably more critical of the correct loading on the amplifier output.

This means that the use of the inductive loading provided by the loudspeaker voice coil results in a transient response which is probably worse than it would have been if the "finagle" had not been employed.

WIDE RESPONSE

This fact accounts for the roughness in the high frequencies, observed with a number of amplifiers whose measured performance shows no trace of over-accentuation of the high frequencies, ringing on square waves, or distortion in this region.

Perhaps a word is not out of place here, as to why this technique is employed. It arises principally from the current fashion for amplifiers to have a frequency response as near as possible from zero to infinity.

Since zero to 20 cycles does not sound like a very big "piece," but 20 kilocycles to infinity sounds like an enormous range, the concentrated effort has been on the latter end. As a result, amplifiers have been produced with specified frequency response extending to 30, 50, 100, and even 200 kc.

While some of our high-fidelity cartoonists have suggested that such amplifiers are for the birds, this trend has generally been taken rather more seriously. Because of this, amplifier designers have been faced with the necessity of meeting specifications of this kind, dictated by the promotion or publicity departments of their companies.

LOW FREQUENCY END

To get the amplifier to perform to these specifications, they have virtually had to resort to the kind of tricks we have mentioned, because the only alternative requires an output transformer whose price would be prohibitive.

So much for the high-frequency end. The low-frequency end seems to have escaped attention although, as we found, its effects can be disastrous with some kinds of program material.

Most amplifiers probably have a stability margin at the low-frequency end of at least 2 to 1, or 6 db, and probably as much as 12 db.

But, to avoid any peaking effect at a subsonic frequency, they need a margin in the region of 18 db.

Unfortunately this peak does not show up in the measured response, because it occurs in the loop gain characteristic and may not show up at the amplifier output, due to the low efficiency of the output transformer at this frequency.

That is a rather technical distinction —just what does it mean to amplifier performance? A peak in the response

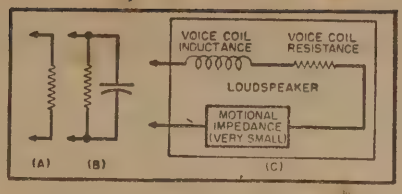

Fig. 2: (A) Common load used for testing although (B) is occasionally used. (C) Actual load offered by speaker to amplifier.

Fig. 3: (A) Good square wave applied to input and seen at output of very good amplifier. (B) A more common output waveform.

anywhere means that any transient condition can cause the system to ring at this frequency. If the amplifier has any kind of peak in the region of 1 or 2 cycles, a transient condition can cause the amplifier to produce a kind of low-frequency flutter of this frequency, which may take a few seconds to die away. But what kind of transient would do this?

The frequency of ringing is down at one or two cycles, so the normal transient, with a sharp wavefront, will not necessarily cause this kind of ringing. The waveform that will produce it is one that possesses a momentary DC component. Many of these occur in practical program material

ASYMMETRICAL WAVES

For example, the trumpet waveform we mentioned earlier is quite asymmetrical; this means it is equivalent to an AC waveform, with a number of component frequencies, plus a DC component which offsets the waveform on one side of zero. This probably occurs due to the fact that the instrument is blown and the air coming out constitutes a DC component.

When a stringed instrument, especially a string bass, is plucked, or a percussion instrument is played, these, too, produce a momentary deflection of the wave-form one way or the other from the zero line at the start of the tone.

Thus it can be seen that any of these kinds of program material can initiate the low-frequency ringing we have described.

In the old-fashioned kind of amplifier, without feedback, this kind of program material will produce a momentary change of bias on each stage through the amplifier. The time taken for each bias to change will depend on the time constant, as it is called, produced by the coupling capacitor and the associated circuit resistors.

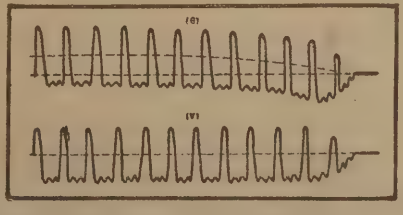

Fig. 4: (A) Asymmetric wave without isolating d.c. (B) Offsetting bias adjustment.

In other words, a continued trumpet tone will cause the bias on each stage to readjust itself by some fraction, and each stage will take a moment or two to settle down to its new bias value. This is illustrated in Fig. 4.

The time taken for each stage to settle down will be dependent upon the time required for the coupling capacitor to change its charge: larger capacitors will take longer and smaller ones will allow the change to take place more quickly.

EFFECT OF FEEDBACK

In a non-feedback amplifier all these changes will take effect at so slow a rate they will not contribute any audible difference to the sound of the output

But when feedback is applied to the amplifier, all these time constants interact so as to make the amplifier almost into a low-frequency oscillator. It does not quite oscillate, otherwise the amplifier would be audibly unstable, but any of these transients coming along will set it into a momentary state of oscillation, which takes a few seconds to die away.

The oscillation itself is not audible, because it is only at one or two cycles and the output transformer prevents any appreciable voltage at this frequency appearing across the loudspeaker voice coil, also the loudspeaker does not produce appreciable response at this very low frequency. However, the low-frequency fluctuation occurs at measurable amplitude at some point inside the amplifier circuit itself.

The asymmetrical kick given by the program waveform can set up an oscillation twice as big as the effective DC component. This means that quite a large fluctuation can occur inside the amplifier which will not be audible outside of it.

So why does it cause trouble? Because the gain of every stage in the amplifier varies with operating bias. This low-frequency fluctuation is like a periodic changing of the bias of several stages through the amplifier.

INTERMODULATION

Consequently the program material gets modulated at this low frequency. What we hear, then, is due to an intermodulation of the program material by this low-frequency oscillation

If the feedback were not present (which, of course, is an impossible state to imagine, because the feedback is what is causing the oscillation), the effect most noticeable would be that the whole program would sound as if an electronic tremolo had been added. However, the presence of a large amount of feedback stabilises the gain of the amplifier so the tremolo effect is not noticeable.

Instead, the same intermodulation that would cause a tremolo effect, but for the feedback, produces a much larger amount of IM distortion in the amplifier than occurs under static measurement conditions.

This results in the harshness often observed in modern feedback amplifiers.

(Continued on Page 89)

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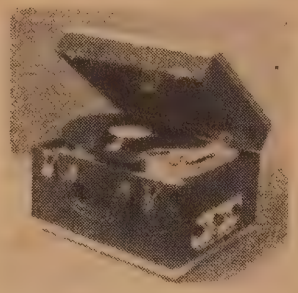

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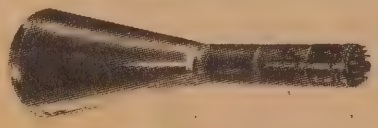

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DO AMPLIFIERS SOUND DIFFERENT?

(Continued from Page 87)

These observations are not just the result of theorising. To substantiate this, two amplifiers of conventional design were taken and modifications made to bring their designs into line with the established mathematical theory, giving the required stability margins at both ends of the frequency response to avoid peaking under any circumstances.

These changes resulted in a slight deterioration of the frequency response, but in neither instance did the response drop below 1 db at 30 cycles or 15 kc., which is still considered to be high fidelity. It is doubtful—extremely doubtful—whether a difference of 1 db at either 30 cycles or 15 kc, could possibly be heard "for itself alone." A-B checks were then conducted between the amplifiers, using their original circuits and the revised feedback circuits.

A difference was quite noticeable in the reproduction of program material, particularly with the kinds of program material in which, as has been discussed, there is asymmetrical waveform—when wind instruments are playing, or string instruments are played by plucking.

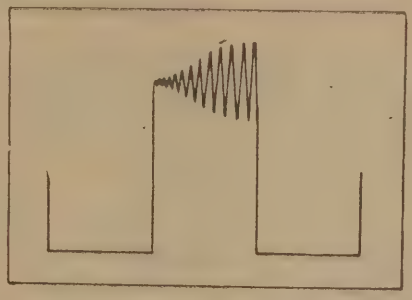
These experiments certainly seem to have uncovered at least some of the major differences that can exist between amplifiers with equally good specifications—differences that do not show up, at any rate, in the standard method of specification. These are, in fact, defects that are not in the book!

—By special arrangement with Radio and Television News.

EDITOR'S NOTE

Mr. Crowhurst's article raises some very pertinent points. Nearly all of them have been dealt with in our columns over the last few years as the result of amplifier tests made during the design and development of Playmasters.

His final point concerning motoboating being caused by a type of high frequency oscillation was very neatly illustrated by an oscillogram tracing which appeared on page 83 of last month's issue, and which is reproduced here.



This tracing showed what remained of a square wave pattern after passing through an amplifier which went into supersonic oscillation on one-half of the input cycle. This amplifier exhibited incurable low frequency oscillation at the same time.

In discussing the reasons for this, we advanced the same explanation as Mr. Crowhurst, and it would be hard to imagine a more effective example of it.

His point about the danger of large amounts of feedback causing instability due to peaks, which are apt to grow at supersonic frequencies, was made some years ago during a series of amplifier tests using the ultra-linear circuit.

This is one reason why we have always advocated restricting single-loop feedback to a maximum of 20 db., particularly as home built amplifiers are liable to use output transformers of differing characteristics.

EXTENDED RANGE

His comments about the wisdom of using extended range output transformers, apparently apply to components of poorer quality than the best obtainable in Australia. Our transformers are expensive, and probably are included in the class Mr. Crowhurst considers are "prohibitive," but by the time labour and materials are paid for in our smaller factories, there is little to be saved by skimping on design.

In practice, we find that, provided there are no sudden peaks of appreciable amplitude which require considerable compensation, our amplifiers have an adequate safety margin.

But with very large amounts of feedback this may not be the case.

A perfect transformer with a completely flat frequency curve, of course, could accommodate an almost infinite amount of feedback without instability, limited only by possible phase shift in the amplifier itself.

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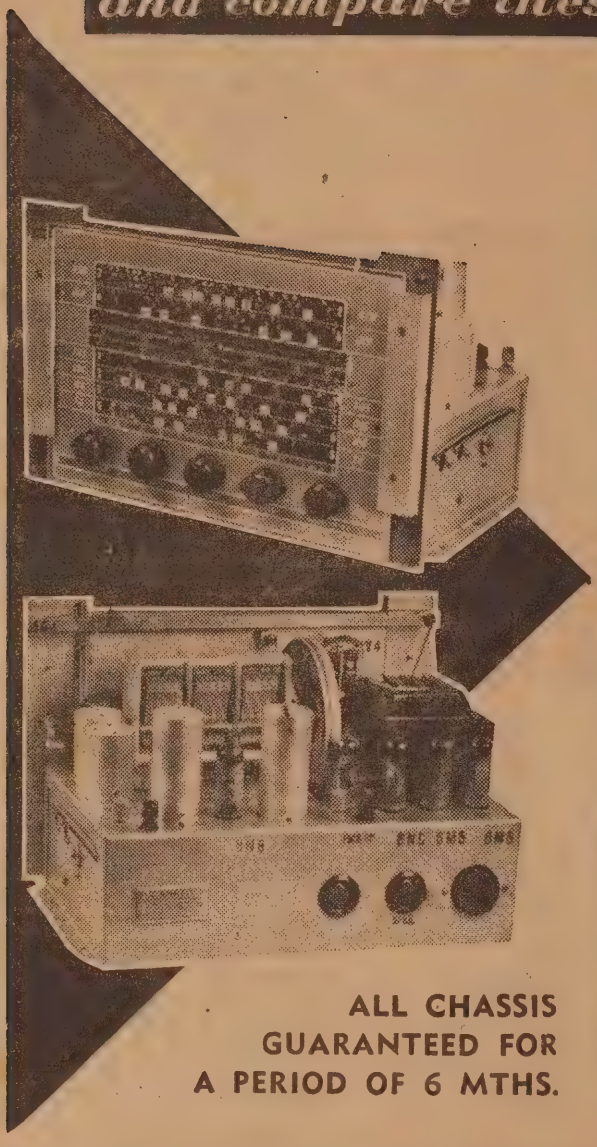

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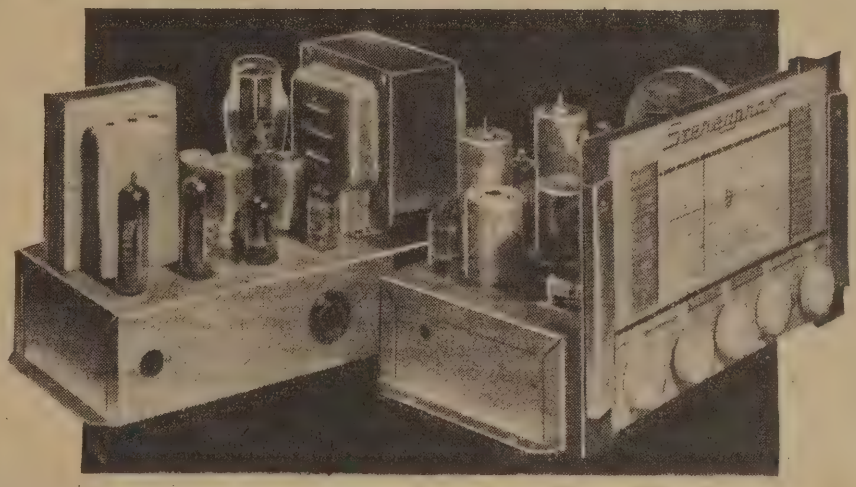

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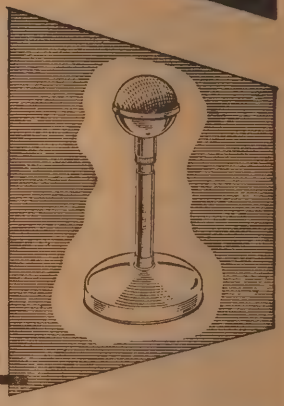

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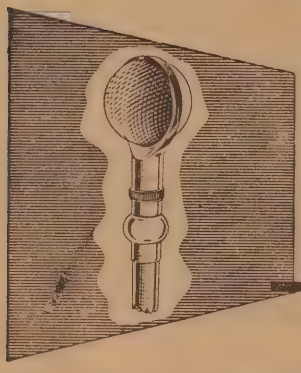

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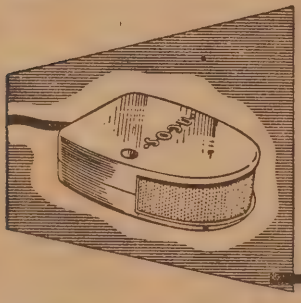

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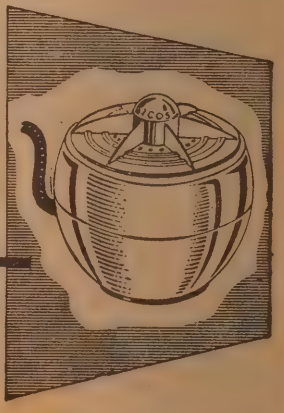

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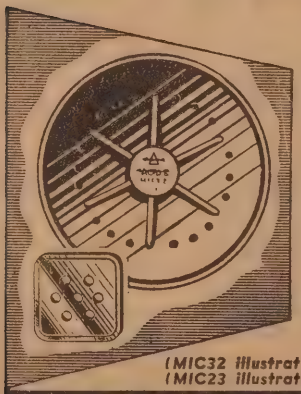

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Here's your answer, Tom!

Tom's first worry, this month, concerns the different classes of operation for power amplifiers. We answered an exactly similar question for a reader some years ago but, since it is of wide interest, it may be well worthwhile to repeat the answer.

APPARENTLY Tom has been reading through some of our technical articles, where the term "Class-A amplifier, Class-B amplifier" and so on occur fairly regularly.

What is the difference between A, B, AB1 and C classes of operation in power amplifiers?

One might suggest, rather facetiously, that bias problems are far older than radio itself. As long as children have been in the world they've pestered their parents with the oft-repeated request to "bias this" or "bias that."

In the radio sense, bias is a lot younger than it ought to be, because its benefits were not generally appreciated until well after the amplifying triode had come into use.

IT AMPLIFIED!

In those days, it was wonder enough that a small signal could be fed to the grid of a valve to produce a much larger signal at the plate. It was of secondary importance that the signal was somewhat blurred—the main point was that it was loud!

The blurring of the signal which we now more correctly call "distortion" was largely due to the fact that the valve did not amplify the incoming signal faithfully. The signal wave patterns would be fed to the grid in a fairly pure form, only to emerge from the plate circuit with the tops flattened, the sides kinked and so on.

It was then discovered that valves could amplify more faithfully if a small negative voltage was applied to the grid and this came to be known as the "grid bias" voltage.

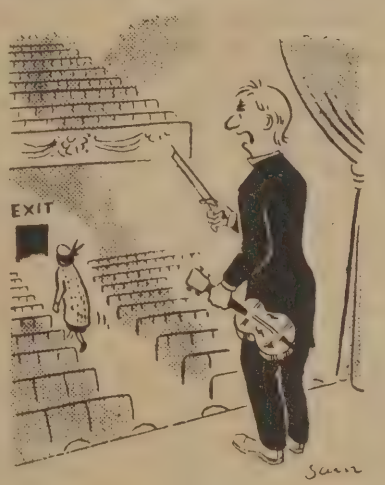
Since then we have learned a lot more about the use of bias. Instead of being an afterthought, it is one of the vitally important operating potentials for a valve. Just as you arrange for the appropriate filament and plate voltages, so must you apply the correct bias, if the valve is to operate properly.

Now this class A, class B, class C business has nothing to do with the merit of the valve, but describes the general condition under which the valve is to operate. Why the terms should have been chosen, goodness only knows, but then why should we call a thing with six legs an insect? It's just a name, after all.

However, when the bias is adjusted on a valve so that it amplifies faithfully the whole of the input signal wave, the grid never actually going positive with respect to cathode, we say that the valve is operating under class A conditions.

Most of the valves in an ordinary set operate under class A conditions, irrespective of whether they are amplifying at radio, intermediate or audio frequencies. If something were to upset the operating conditions of one or more of these amplifying stages, the signals would become distorted. You've learned the first point.

In the course of time, it was also discovered that valves could be operated in pairs in what is now called the "push-pull" circuit. The immediate benefit of such an arrangement is the ability of the valves to deliver much louder signals than a single valve working alone in the output stage of a receiver.



"Mother! I haven't finished yet!"

It was also noted that the power output, or loudness of the signals, could often be increased by making the bias more negative than normal and feeding the grids with such a strong signal that they were actually driven positive on signal peaks.

In actual fact, the bias was made high enough so as to cut off almost completely the initial flow of plate current, so that economy of battery drain was one of the powerful "talking points" for this class of operation in the early battery sets.

Distortion is avoided, despite the high bias, because the two valves have a complementary action, each one amplifying faithfully the respective halves of the input signal.

The technique of operating valves with an abnormally high bias and driving the grids harder became known as class B operation.

Of course, that isn't the end of the story, Tom. The valves have to operate into a suitable order of load and the driving signal must come from a stage which is, itself, capable of delivering a certain amount of power. Fortunately, you don't have to work these things out yourself, because the necessary bias, H1 voltage, driving power and so on, are listed by valve manufacturers in their valve manuals.

Compromise conditions have been worked out for modes of operation which lie between pure class A and pure class B operation. These, appropriately enough, have come to be known widely by the terms class AB1 and class AB2.

In both cases the negative bias is greater than would be expected for class A operation. With class AB1 the grids are never driven substantially positive and the previous stage is not called upon to deliver any substantial power to the push-pull grids.

DRIVEN POSITIVE

With class AB2 the grids are driven well positive on peaks and the drive requirements are similar to those for pure class B, the point of difference being that the initial bias is not as high as would be required for class B.

Class C is a special operating condition which is used mainly in transmitters.

In a class C stage the grid is initially biased to well beyond cut-off but is driven positive on the extreme peaks of the input signal. Those are the general facts, Tom, but there are a few points which might confuse you. For example: not all valves working under class B conditions have a high applied bias. In fact, some operate with no bias at all.

As mentioned previously, almost twice the bias of a class A stage is required for class B operation and this will normally be sufficient to cut off the flow of plate current in the absence of signal.

When a valve has a relatively low amplification factor, as is often the case with power output valves, quite a large bias is required for class B operation and this is sometimes quite awkward to provide.

Recognising this difficulty, the valve designers have produced, from time to time, valves which have so many turns on the grid that it severely restricts the natural flow of electrons to the plate. Even with no negative bias on the grid, the plate current in such a valve might be quite low. In other words, it satisfies the class B requirement of being biased to cut off even with zero grid bias.

The moment a signal is applied, it drives the grid positive on the positive peaks and the rest of the bargain is ful-

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filled. Such valves, of course, are not suitable for class A operation because they are always at cut-off.

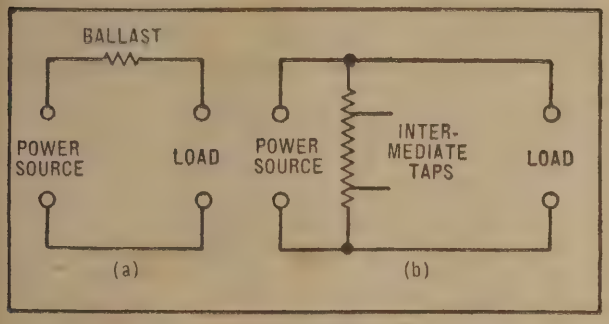
A class C stage does not amplify in all the normal sense of the term. It serves, rather, to deliver abrupt and powerful bursts of signal to a tuned circuit and keep it oscillating at its natural resonant frequency.

It's just like the pistons of a motor car. They don't deliver all the time, but only in bursts during the power stroke. The big flywheel alternately stores and delivers energy and transmits a relatively smooth drive to the rear wheels.

★ ★ ★

Is a "ballast resistance" the same as a "voltage divider"? If not, please explain their difference.

The term "ballast resistor" is usually applied to a resistor with a high temperature coefficient of resistance, used to maintain a constant current in spite of votlage variations.



☆

A ballast resistor (a) tends to maintain constant current through the load circuit. A voltage divider (b) provides intermediate voltages between maximum and minimum.

☆

In plain words, Tom, a ballast resistor is made from a metal alloy which has the characteristic of increasing its resistance with an increase of the current flowing through it, due to the heating which takes place.

The increase in resistance causes an increase in voltage drop across the resistor which, in turn, decreases the current flowing through it, thereby tending to keep the current more nearly constant.

Barretters and such-like devices are well known examples. A barretter, for example, consists of an iron-wire filament in a hydrogen-filled glass envelope and looks like a "cross" between an ordinary incandescent lamp and a radio valve.

Ordinary resistors are sometimes referred to as ballast resistors, a well known example being the ballast resistor in a battery charger. Its purpose is merely to limit maximum current.

A voltage divider is usually connected in parallel rather than in series with the supply. Its prime purpose is to provide one or more taps so that the voltage between these and one end of the resistor may be varied. The current flowing from these points through an external circuit is a deciding factor as to the value of resistance required for a given voltage drop.

★ ★ ★

Is the gain of a valve the same as the mutual conductance?

No, Tom. Although intimately connected, they are not the same thing. Gain is a pretty general term used in voltage amplifying stages to denote the ratio of output voltage to input voltage.

On the other hand, in a power output stage we are primarily interested in the power available to drive a loudspeaker for a given signal input voltage.

The gain of valve amplifying stage is dependant on three main factors, the valve's own plate resistance, the plate load resistance and the mutual conductance of the valve.

An increase in any one of these quantities will tend to increase gain, so that all three have to be considered in determining the final figure.

The most that one can say is that a valve having high mutual conductance will end to give higher gain than one having low mutual conductance, all other things being equal.

★ ★ ★

What is the difference between a modulated oscillator and a signal generator? What are they used for?

Generally, the term signal generator refers to the better-class instrument, while a modulated oscillator describes a less pretentious instrument of the same species.

Both instruments generate frequencies, from the superhet IF channels to high radio frequencies which allow one to align the tuned circuits of a receiver to their correct frequency of operation. In the case of the signal generator, we would expect to find reasonably accurate frequency calibration and, even more important, an accurate means of measuring the voltage output of the instrument at all times.

When measuring the performance of highly sensitive modern receivers, the leakage of the attenuator must be very low.

Most signal generators make provision for modulation either of fixed or variable frequency and also provide for adjusting the modulation to known depths.

An oscillator, on the other hand, consists simply of a valve working as a radio frequency oscillator and usually covering from about 150 Kc to, say, 30 Mc with a dial giving the approximate frequency and some simple form of attenuator, the latter not generally calibrated to any degree of accuracy.

An audio frequency oscillator is usually provided for modulation purposes, but the percentage of modulation is not accurately indicated.

In general, an oscillator is quite suitable for adjusting domestic receivers, but a signal generator is required for making accurate performance measurements and for adjusting more elaborate equipment, such as communications receivers.

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A COURSE IN TELEVISION

PART 22 — VIDEO AMPLIFIER STAGES

Next step in the study of television receivers is to discuss the subject of video amplifiers. While they are often compared in function to the audio amplifier in an AM broadcast receiver, the comparison can only be superficial, the design of a video amplifier involving distinct and unique problems.

BY way of definition, the video circuits in a television receiver are those concerned with amplifying the signals, which emerge from the video detector, to a degree where they can modulate fully the intensity grid of the picture tube.

They are therefore broadly synonymous with the audio amplifier circuits in a sound receiver, which take the signals emerging from the detector and amplify them to a level sufficient to operate a loudspeaker. There the likeness ends, however.

Whereas audio circuits are concerned with frequencies only up to about 15Kc, video amplifier circuits should ideally be able to handle all picture frequencies radiated by the transmitter and these extend to about 5Mc.

UPPER FREQUENCY

In other words, a video amplifier should be able to handle, as a matter of course, frequencies ranging up to three times those used for the carrier itself, in ordinary broadcast-band transmission. Its bass response must also be better than that of a conventional audio amplifier.

This is the first major requirement. If the overall pass-band of the video system is not wide enough, the picture quality must inevitably suffer through loss of shading and fine detail.

A second requirement is that, notwithstanding the wide pass-band, a video amplifier must be capable of providing the requisite gain and output voltage to vary the picture tube scanning beam intensity between zero and the maximum required figure.

Lack of gain, in association with the rest of the receiver, will prevent a picture being presented having the full range of tones from black to white. The effect is most noticeable, of course, with weak input signals.

As distinct from gain, insufficient signal output voltage, leading to non-linear effects and overload, can likewise impose limits on the tone range of the picture. Attempts to obtain greater contrast in the face of such limitation merely causes more of the picture area to merge with limiting tones at one or both ends of the tone range.

What happens, very simply, is that the video output stage overloads and "flattens off" before it can carry the writing beam to one or both of its normal intensity limits.

Picture tube grid signal requirements vary a good deal with the type of tube, operating potentials and viewing conditions but peak-to-peak signal requirements may approach 70 volts.

It should be noted, in passing, that signal levels in the video, synchronising and deflection circuits are normally specified in terms of peak-to-peak voltage. This is necessary because, with the non-symmetrical, angular waveforms involved, simple peak and RMS quantities are meaningless.

Over and above the basic requirements of frequency response, gain and output voltage, various other important matters have to be considered.

These include: (1) The possible need to provide video gain control; (2) A choice as to the number of video stages which can conveniently be provided; (3) The observation of correct polarity for the picture signal; (4) The preservation or otherwise of the DC component.

Certain of these points have already been covered in earlier discussion but may warrant some repetition in this present context. Firstly, the matter of signal polarity:

With negative modulation, the darker picture areas produce increased carrier amplitude, peak amplitude or power occurring during synchronisation pulses. This means, in turn, that the detector delivers high output voltage at intervals when a "black" signal is being received.

NATURE OF CIRCUIT

In modern receivers, the detector is almost invariably a thermionic or crystal diode and the polarity of its signal output in respect to chassis depends on which way round it is connected into circuit and/or whether the load resistor is placed in its anode or cathode return.

During intervals when "black" or synchronising signals are being transmitted, the detector may therefore deliver maximum positive-going or maximum negative-going signal voltages across its output load resistor.

When the detector is polarised to give peak negative output on synch. pulses, it may be said to be delivering a signal of "negative synch. phase" or "positive picture phase." Both expressions describe the same condition and merely indicate that the synch. pulses are negative-going in sense while the picture information is simultaneously positive-going, both referred to chassis potential.

Reversing the detector would reverse the sense of its output signal, so that it could be described as "positive synch. phase" or "negative picture phase."

The same terminology can be used, if desired, to describe the signal throughout the entire video system.

In a practical receiver design, the polarity of the detector may well be dictated by the need for it to produce simultaneously a negative DC potential for the automatic gain control system. Where such is the case, the designer must arrange the number of video stages and the signal feed to the picture tube to ensure a "positive" image on the screen.

Were the signal applied to the picture tube to have the wrong polarity, the modulating action on the writing beam would be reversed. Dark areas would become highlights and vice versa, producing a photographic "negative" rather than the desired image.

The matter of signal phase is therefore vitally important in a video system whereas, in audio practice, it is of no special consequence.

A normal resistance-coupled video stage, with input to the grid and output taken from the plate, produces a phase change approximating 180 degrees. Thus a detector signal, which is negative-going on peaks, becomes positive-going after traversing one such stage.

A second video stage of the same type will produce a further 180-degree shift, making 360 in all and reverting the signal to the same sense as from the detector.

If a video stage is operated as a cathode follower, the phase of input and output signals is nominally the same.

Also significant in the matter of phase is the signal feed circuit to the picture tube. Most, if not all, modern picture tubes have a specially insulated cathode giving the same order of input capacitance as the intensity grid itself.

By way of example, the 17HP4-B has an input capacitance, grid to all other electrodes, of 6 pf, while cathode to all other electrodes is 5pF.

To produce a darkening of the trace on the screen, it is necessary to impose a negative-going signal on the intensity grid, the cathode meanwhile being held to chassis potential as far as the signal frequency is concerned.

SIGNAL PHASE

Since it is necessary to darken the trace for "black" signals or during the transmission of synch. pulses, it may be said that a picture tube, at its grid, needs a signal of "negative synch. phase" or "positive picture phase."

Conversely, the same effect on the beam can be achieved by holding the grid at chassis potential for the signal frequency and applying a positive-going signal to the cathode.

Thus, for cathode signal injection, a picture tube requires a signal of "positive synch. phase" or "negative picture phase."

While it is perfectly practical to feed the video signal either to grid or to cathode, one particular factor favours the latter consideration. This arises from the operating condition of the final video amplifier.

While this operates nominally as a class A voltage amplifier, conflicting requirements of gain, bandwidth, output and economy normally prevent the provision of any great overload margin. The stage may therefore have to operate into the curved portion of its characteristic, particularly as the grid swings toward plate current cut-off.

This being so, it is an advantage to have this occur when the writing beam is being blacked out. On the opposite swing, when the picture tube is producing highlights and therefore the most obvious portions of the picture, the video amplifier is operating over the straightest portion of its characteristic.

BEST LINEARITY

A little thought will show that a positive-going swing (positive picture phase) on the grid of the final video amplifier, will produce increased plate current and therefore a negative plate voltage swing. Coupled to the cathode of the picture tube, this negative-going signal will produce a picture highlight, as required. The positive-going "black" and synch. peaks, possibly subject to some non-linear distortion, will produce little or no light on the picture-tube face.

These considerations covering the phase of the signal and the manipulations which are possible, result in a variety of basic circuit patterns for typical video systems.

Undoubtedly, the most common is a detector producing negative-going signals on "black" peaks, together with a negative DC potential which is available, if required, for AGC purposes. The video signal is then passed through one amplifier stage, so that it becomes positive-going on "black" peaks, this signal being applied to the cathode of the picture tube.

In a more elaborate receiver, the designer may prefer to employ two video amplifier stages, for the sake of increased gain, more convenient gain control, more facility in the provision of trap circuits and/or the achievement of wider frequency response.

Two stages, plate loaded and operating in cascade, would deliver an output signal of the same sense or polarity as the input. This would involve either reversing the polarity of the detector and feeding the signal to picture cathode, or maintaining a negative-going signal from the detector and feeding the video output to the picture tube grid.

CATHODE FOLLOWER

Yet another possible arrangement is to use a two-stage video amplifier but with the second stage operating as a cathode follower. Because this second stage introduces no significant phase shift, the convention is to have a negative synch. phase signal from the detector, a positive synch. phase signal from the first video stage and the same again from the second video stage, feeding the picture-tube cathode.

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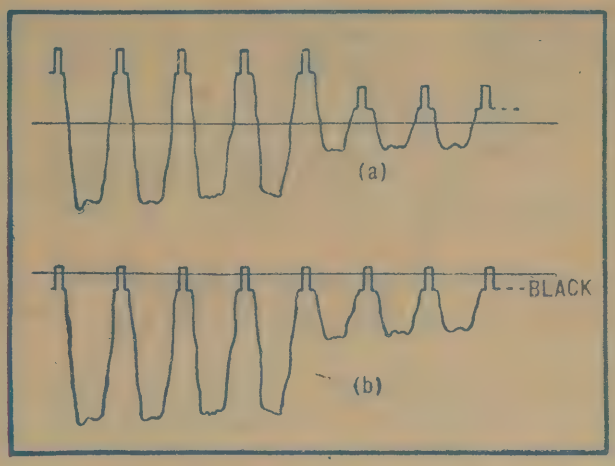
Figure 132: Though considerably exaggerated, diagram (a) indicates the nature of a video signal after loss of the DC component. Diagram (b) indicates the effect of DC restoration, the signal having the same character as that from the video detector.



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An interesting variant of this scheme is to have the second of two video stages operating with part plate and part cathode loading. Output is taken from the cathode to the picture-tube cathode and from plate to picture-tube grid. Though more complex, the divided load idea allows the relevant circuit capacitances to be more or less connected in series across the total output circuit of the final video amplifier.

Typical circuits, illustrating these various arrangements, will be given later but enough has been said here to indicate the way in which consideration of signal phase dictates the basic pattern of the video circuitry.

It may be noted that no mention has been made of economy designs, omitting the video amplifier and feeding the detector output directly to the picture tube. Such receivers have, in fact, been produced using grid, anode-bend or reflex detectors.

NOT CURRENTLY USED

By and large, however, they were confined to the early English scene where there was no need to consider multiple channels, special pass-band characteristics or the use of automatic gain control. Nowadays, such designs are rarely encountered.

The significance of the DC component has already been discussed in an earlier article in this series. It was pointed out there that a video signal is nothing like an audio signal and is not symmetrical about some intermediate reference voltage. Rather must it be considered as a potential which varies in an abrupt, non-repetitive fashion, according to the variation in light and shade along each individual scanning line.

On this basic waveform is superimposed signals, artificially generated which are intended to synchronise the receiver scanning circuits with those at the transmitter, and to black out the viewing screen at the same time.

The instantaneous output from the receiver's video detector is — or should be — exactly proportional to the amplitude of the incoming picture carrier. The peak output voltage from the detector during synch. pulses will be constant for any given input signal, the general level of the video information between pulses rising or falling according to whether the picture content is light or dark or just average.

In other words, the basic output from the video detector is a DC potential which is subject to very rapid and substantial fluctuation but which reaches a certain peak value during each individual synch. pulse.

In an idealised video amplifier, the signal never loses this basic character. The detected signal is directly coupled to the input of the video amplifier and appears at the output as an exactly proportional variation in DC level.

It is directly coupled, in turn, to the picture tube input circuit, either to grid or to cathode, as dictated by polarity requirements. Since the signal may be superimposed on the plate supply potential of the video output stage, the other picture tube electrode—cathode or grid — must be returned to a comparable potential so that the correct bias relationship will be established between the two.

Under proper conditions, the relationship between the signal and the standing voltages would be such that the beam would be visually extinguished at the exact instant when the incoming carrier amplitude achieved 75 per cent. of its peak value, corresponding to the official black level.

Increased carrier amplitude during synch. pulses would carry the picture tube even further into the cut-off region, while decreasing carrier amplitude would produce increasing screen illumination.

EFFECTIVE WHITE

The controls would normally be set so that the peak beam intensity, judged necessary to produce a visual sensation of white, would occur at a carrier level equal to 10-15 per cent. of maximum.

Unfortunately, the design of a directly coupled video system is attended by the usual difficulties of any DC amplifier, particularly where more than one stage is involved.

A plate, normally positive with respect to chassis, must be connected to a following grid which needs, in turn, to be less positive than its own cathode. These varying DC levels throughout the circuit have to be reconciled without prejudicing the operation of any one stage.

The circuit design, furthermore, has to be sufficiently non-critical to prevent normal component variation and drift in

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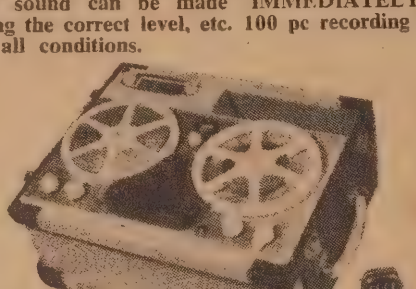

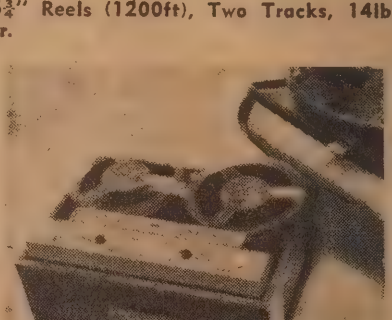

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one part of the circuit from upsetting the voltage or current relationships in another.

Last but not least, the provision of Brightness and Contrast (i.e. video gain) controls may be hampered because of their possible reaction on the DC levels throughout the circuit.

OTHER PROBLEMS

Even if a change in DC levels is insufficient to distress a particular valve or component, it can cause troublesome interaction between the controls or change the potentials enough to prevent the blanking pulse from erasing completely the retrace lines.

Because of these difficulties, many designers do not attempt to maintain direct coupling right through the video system. They use it where it presents no special difficulty, resort to capacitive coupling where it suits them and then re-create a DC component by the use of a DC restorer.

Readers are reminded that an article on "The DC Component" appeared in the March 1957 issue and the phenomena explained of DC loss and DC restoration.

Figure 132, reproduced herewith, will serve as a reminder. Though grossly exaggerated in effect, diagram (a) shows how a video signal, after passing through an R/C network, tends to equalise about some average reference, such that the energy in the positive-going excursions balances that in the negative-going excursions.

Diagram (b) illustrates the same signal after a DC restorer has aligned the synch. peaks once again.

In many current receiver designs, AC coupling is used without any attempt being made to preserve or restore the DC component in the basic video amplifier. The scheme is claimed to simplify design problems without prejudicing the entertainment value of the picture.

The chief difficulty about simple AC coupling is that it allows some degree of wander in the effective height of the blanking and synch. pulses, as illustrated in figure 132. Under certain signal conditions, as when the screen is predominantly dark, the effective amplitude of the pulses may diminish sufficiently for them not to blank out the beam during the retrace periods.

FRAME RETRACE

This is most objectionable in respect to the frame retrace, which might cause a half-dozen or more lines to appear slantwise across the screen.

Where AC coupling is used in the video amplifier, with no DC restoration, it is therefore common practice to provide a built-in frame retrace blanking circuit. This involves a simple coupling circuit from the frame output transformer to the grid or cathode of the picture tube. The nature of the coupling and the polarity of the resulting signal must be arranged so that, during the abrupt flyback pulse, the beam is momentarily blacked out.

The arrangement is similar to that used for retrace blanking in ordinary test oscilloscopes.

AC coupling with retrace blanking appears to be favoured particularly in the U.S. It is suggested that this is partly due to failure of U.S. television stations to observe strictly official standards governing the ratio of blanking level to peak carrier power.

This creates obvious differences in picture quality and in the effectiveness of retrace blanking as a receiver is switched from one Channel to the next. Under such conditions, a receiver with AC coupling and built-in retrace blanking may have an actual advantage, as far as ease of operation is concerned.

Two points remain to be covered in this preliminary survey of video systems. The first is the Brightness control.

The essential function of this control is to vary the standing bias between grid and cathode of the picture tube and therefore the average brightness of the image on the screen.

Advancing the Brightness control reduces the standing bias between grid and cathode and makes all portions of the picture brighter, both the highlights and the shadows.

VARIES BIAS

In many cases, the Brightness control is simply a potentiometer which supplies an adjustable voltage to grid or to cathode through its normal return resistor. The most convenient arrangement is usually to have the cathode returned to a potentiometer connected in part between the HT line and chassis.

In special cases, the brightness may be controlled by varying a potential at an earlier point in a directly coupled video amplifier, the consequent change in DC level affecting bias on the picture tube.

As distinct from the Brightness function, a Contrast control must increase the difference in contrast between light and dark portions of the picture. This involves the application of a larger video signal to the picture-tube grid or cathode, as the case may be.

In some receivers, the Contrast control operates in the front end of the receiver. It may be a simple manual control varying the bias on certain RF or IF amplifiers or it may modify the AGC circuit to permit a larger signal to pass to the video detector and thence through the video amplifier to the picture tube.

GAIN CONTROL

In other receivers, the Contrast control operates purely in the video amplifier as a simple gain control.

Here an immediate difficulty occurs, because the conventional scheme of using a potentiometer across the signal source, with the following grid to the moving arm, is quite unsuitable. At various settings, capacitance effects across the potentiometer are likely to give a rising or falling high frequency characteristic.

Difficulty also arises because the impedance between grid and chassis varies with pot. setting and, with it, the significance of valve input capacitance.

Alternative schemes must therefore be found, such as varying the screen voltage of a pentode amplifier or introducing a variable unbypassed resistor in the cathode return circuit. This latter operates largely by virtue of its degenerative effect, though it also changes the bias and current levels.

We shall have more to say about these matters in the next issue.

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TRADE REVIEWS AND RELEASES

"ADVANCE" CRYSTAL STANDARD CHECKS SIGNAL GENERATOR CALIBRATION

"Advance" Crystal Calibrator type 74 is intended as a calibration check for signal generators over the frequency range from 1Mc/s to 250 Mc/s and should be a useful addition to service departments and laboratories concerned with VHF communication and television equipment.

Overall dimensions of the advance instrument are 7¼in high by 7⅝in wide by 7in deep. The weight is 9lb.

THE heart of the instrument is a 5 Mc/s crystal oscillator of high accuracy. A multivibrator operating at a fundamental frequency of 1 Mc/s is locked to the crystal oscillator and gives a series of accurate calibration points at 1 Mc/s intervals over the frequency range.

The output of the signal generator under test is fed to the input terminal of the crystal calibrator. Circuitry is arranged so that the incoming signal beats with either the 1 Mc/s or the 5 Mc/s oscillator or their harmonics. The output of the mixing stage is fed via a volume control and an audio frequency amplifier to either an inbuilt loudspeaker or a phone jack while a magic eye tube serves as a visual indicator.

According to the manufacturer's data the instrument is capable of an accuracy of better than plus or minus two parts in 10,000 plus or minus 15 c/s with the visual indicator. Accuracy is not quite as good with the aural indicator but the latter is extremely useful in establishing the approximate calibration point. Sensitivity is such that a satisfactory indication can be obtained with input signals having an amplitude of 10 mV or less.

The instrument was used in our own laboratory to check the calibration of a signal generator covering up to 300 Mc/s, and no difficulty was experienced in identifying calibration points at the high end of the range.

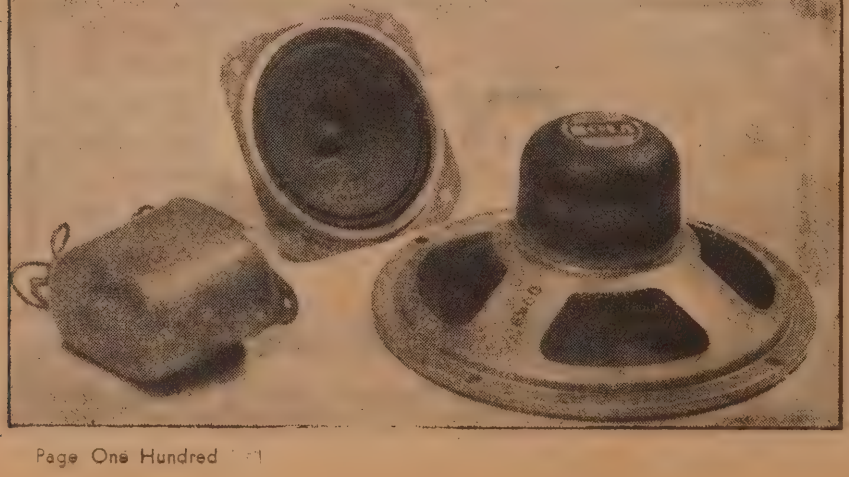
The price is £48/15/. Further information can be obtained from Jacoby, Mitchell and Co. P./L., of 477 Kent Street, Sydney.

TELEVISION SPEAKERS FROM ROLA

A POSSIBLE difficulty when loudspeakers are placed close to the picture tube in a television receiver is distortion of the picture due to the external field of the speaker magnet.

Both the 6M and the 3C models, illustrated here, are fitted with magnetic assemblies designed to cut external fields to a minimum and, therefore, are suitable for use in table model television receivers. A practical test indicates that the 6M can be mounted alongside the picture tube as specified in the R.TV and H design appearing in this issue.

Common practice is to use the 3in and the 6in speaker together in the one receiver, the small speaker being mounted in the front of the cabinet and the larger speaker on one of the sides.



LATEST PHILIPS TRANSISTORS

DATA on transistors types OC44 and OC45 has been available for some time and it is pleasing to note that the supply position is a little better than previously. The interesting technical feature of these transistors is the frequency handling capability making them suitable for many applications previously reserved for valves.

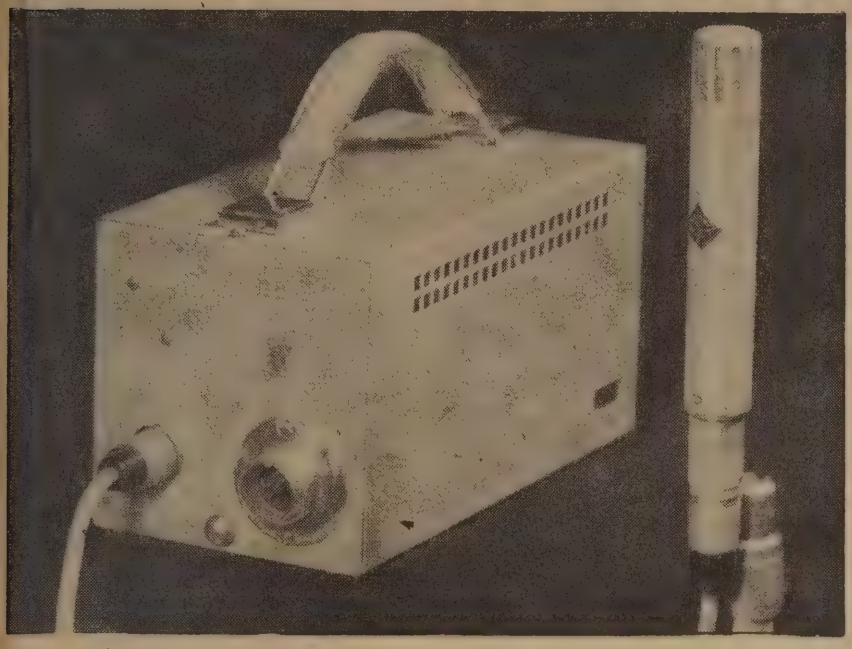
The OC44, for example, may be used as a mixer or oscillator in broadcast band receivers while the OC45 will work efficiently at intermediate frequencies. The list prices are £2/17/9 for the OC44 and £2/15/ for the OC45.

OC44 and OC45 are shown larger than actual size.

Used in conjunction with transistors such as the OC71 and the OC72 a superhet broadcast receiver with performance comparable or better than conventional valve portables is possible with the new transistors. Extremely compact pocket radio receivers would also be possible.

Transistor type OC16 may also be more plentiful in the future. Recently revised ratings suggest that this type may be useful in the output stage of a public address system operating from a vehicle battery without the need for a vibrator or motor generator power supply. The list price is £5/18/4 per transistor but is offset by the saving in cost of other components and power economy.

BROADCAST QUALITY MICROPHONE



One of a very comprehensive range of miniature high quality Neumann condenser microphones was recently forwarded to us for test and examination by Simon Gray Pty. Ltd. of Melbourne, the national distributors for Messrs. Georg Neumann G.m.b.H., Berlin. It is the model KM-54 which is photographed here with its associated power supply.

THESE microphones are widely used in broadcasting, television and recording studios, where good electrical characteristics together with reliability are of importance.

Type KM-54a is a pressure-gradient condenser microphone with a cardiod-shaped pickup characteristic. Its directivity is such that it gives about 25 db rejection to noise coming from behind the favoured pickup area.

Two other miniature types are available, the KM-53 having omnidirectional characteristics and the KM-56 omnidirectional, cardiod or bidirectional characteristics selectable by turning a ring.

It is interesting to note that a Neumann type 49 microphone is available which is arranged so that the directional characteristics can be changed by remote control from an operating position.

In common with all condenser microphones, the output from the microphone proper is extremely low and of an impedance such that it cannot be transmitted by cable over any appreciable distance. To overcome this difficulty, the Neumann microphones have a valve amplifier and output transformer built into the microphone housing. The output impedance from the transformer is 200 or 50 ohms.

LINE FILTERS FOR BROADCAST AND T.V.

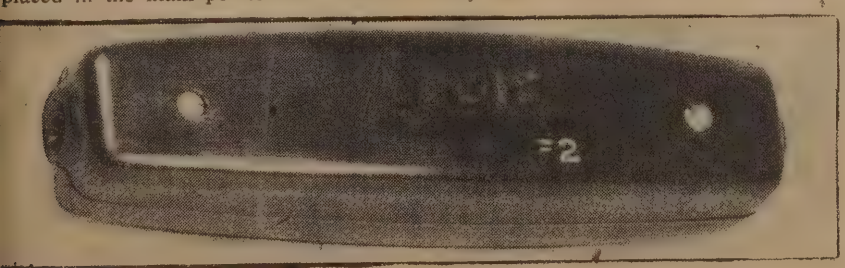
The amount of radio equipment in use is ever on the increase and its usefulness and reliability depends on interference free channels. Television receivers and VHF communication equipment are particularly vulnerable, not to mention normal broadcast receivers.

MUCH interference originates from small electric motors such as are used in sewing machines, vacuum cleaners and egg-beaters, while vibrator-type electric razors can also be serious offenders.

Aegis Manufacturing Co. Pty. Ltd., of 208 Little Lonsdale Street, Melbourne, have made available the power lead filter illustrated here, which is intended to be placed in the main power lead close to the offending device.

Two versions of the filter are available, both in the same moulding. The first contains a special balanced capacitor only, and is intended for use on the broadcast band. The second is intended mainly for T.V. work.

Current through the broadcast unit should not exceed 5 amperes, while the TV filter is rated to carry 2 amperes only.



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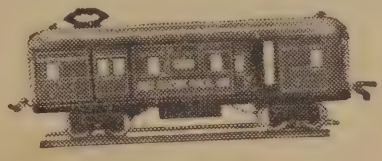

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R&H 7/56

OFF THE RECORD — NEWS & REVIEWS

Last year, when in England, I met Mr. Arnold Sugden, maker of the Connoisseur pick-ups, motors, and audio equipment, and heard demonstrations of his stereophonic records. These records are cut with a groove modulated both laterally and vertically, so that, when played back with a dual pick-up, two channels become available from a single disc.

by John Moyle

THE records I heard were experimental acetates, and the play-back head was not a production type, but the results were quite encouraging.

Now I have news that he has prepared some regular pressings, and it is obvious that he has carried his work considerably further.

In discussions last year, he made it plain that he intended eventually to offer equipment and records for sale using this new principle — new at least as far as the public is concerned.

As far as I know, he will be the first man to do it, if by this time his plans are sufficiently advanced.

Apart from a private hearing at the factory (which is within a good, strong, stone's throw of the Wharfedale Works at Bradford) I heard his records at the British Sound Recording Society's yearly exhibition, at which the first public demonstration was given.

APPRECIABLE SEPARATION

There was little doubt that appreciable separation of the two channels was possible, and despite the experimental nature of the records and equipment, the sound was remarkably good.

The second London Audio Fair which took place at the Waldorf Hotel in May of this year included another demonstration using the latest processed discs, and I have no doubt they would prove much more satisfactory than the earlier efforts.

Reports are that the demonstration was one of the Fair's highlights, and interested more people than just the general public for whom it was intended.

Sugden claims that he is able to accommodate frequencies up to 12 Kc., and achieve a channel separation of 25 db., which should be good enough for realistic results.

The reports I have indicated that the possibility of this type of disc making an appearance on a wider scale seem to be brighter than last year.

All the big record companies I spoke to at that time admitted having experimented with the system, but it was equally obvious that they hesitated to go any further for reasons which might have been as much commercial as they were technical.

MANY DIFFICULTIES

I had the impression that, if someone was game enough to take a plunge with a satisfactory disc, others would follow.

There are many difficulties inseparable with the proposition. Technically it may yet have to be proved that tracing distortion can be kept to an acceptable figure using a groove that has to do so much. It is almost impossible to estimate how serious that distortion would be and, of course, no one has published any figures about it.

Each equipment would require a special pick-up head with a stylus which operated two movements, one at right angles to the other. This immediately suggests very great problems if the mass of moving parts is to be kept low, and the compliance of the system high. It is likely to be more than twice as difficult as for a single head pickup.

I have no details of how Sugden has tackled this problem, but the pickup he was using last year was merely a hand-made device prepared for the occasion using two standard crystal movements.

SO FAR WITH TAPE

So far, all the big companies have preferred to make their twin-channel bow with the use of tape, which initially has no new technical problems, merely the necessity of doubling up on reproducing channels. It risks very little money as compared to launching a campaign on a new type of gramophone record which cannot be played as intended with a standard pickup.

But once the initial step is taken, there could be a future for a disc.

A big attraction of a binaural disc is that it does not depart from the familiar process of placing a record on a turntable and a stylus in a groove.

This is a process as familiar to us as is tuning a radio set.

Tape's big disadvantage for the man in the street is that it is a completely unfamiliar method of playback. And it's still far messier than a neat and attractively packaged record, although plastic tape cassettes have been made which could overcome this objection.

Whereas the lateral-vertical disc might even be made "compatible" — that is, able to be played with an ordinary pick-up which would reproduce the lateral groove only.

If, as some people now maintain, it is only necessary to carry the upper frequencies on the second channel to obtain satisfactory binaural effects, the vertical channel would not even be called upon to acccommodate the full frequency range, probably a big factor in keeping intermodulation and distortion low.

The key to the whole problem seems to be this — will enough people think the stereo feature sufficiently worthwhile to install the necessary amplifiers and speakers?

It is certain that some enthusiasts will, but what about the average man?

In most things, we reach an optimum in performance beyond which only the dedicated will want to go.

It may well be that the present high standard of the single channel record has reached that optimum.

If so, then the future for any stereo system will lie in a specialised market, the returns from which will not compare with those from the main bulk of the record business.

Someone will have to take a risk to find out.

So far, there isn't much room for encouragement in the response to stereo tapes. On a percentage basis, they have been slow sellers.

At the same time there is something sufficiently fascinating in the possibility of the stereo type disc to make it worth watching.

Meanwhile I had my own share of shocks during the month.

PICKUP TESTS

For some time I have been waiting for a chance to make some tests on pick-ups, and to run them through with a disc I brought back from the States containing some excellent square wave and intermodulation test grooves.

For some time I have been plugging the use of recorded square waves as a basis for testing amplifier systems.

It seemed only half the story to test amplifiers with very severe square waves and to condemn them for ringing, when there was no evidence that they would ever receive such steep-sided waveforms from a disc.

On the other hand, I wanted to know what kind of a fist modern recording equipment would make of cutting a square wave at 5 Kc., the frequency most favoured for amplifier testing (at least with me), and what would be the chances of playing it back with even the best of pick-ups.

SQUARE WAVES

The highest square-wave frequency on my test record is 1 Kc., and I anticipated that, for a decent pick-up, this would be a piece of cake.

So I assembled a collection of them. Two were moving-coil types of high reputation, and two were moving-iron types almost equally well thought of.

Maybe you are way ahead of me!

All four pick-ups produced nice, straight sides to their patterns.

But only one produced even an approximation of a straight line along the top!

Both the moving-coil pick-ups gave lovely examples of ringing. The best quality type overshot by about 50 per cent., and its oscillations had not ceased before the end of the flat top was reach-

ed. It was, however, obviously ringing about one frequency, and later tests proved that it had grown a peak at about 14 Kc. since first put into use, probably due to relaxation of the damping material used in the movement.

Its wave-form, however, was very good.

It is only fair to say that this pick-up, in its new condition, and without the lately grown peak, would probably have given a good result. Extra weight on the head, which applied extra damping from the record groove, greatly reduced the amplitude of the ringing, which was now quenched altogether over the last half of the flat top.

In consideration for the record grooves, I didn't persist very long with this practice!

One moving iron pick-up, which did best of the four, showed continuous ringing of low amplitude over the full flat top, but its irregular shape suggested that several frequencies were involved.

This was later verified with a normal frequency check which revealed noticeable wave-form distortion at various spots in its response.

IS THIS TYPICAL?

Had time permitted, it would have been most instructive to have run full ersponse curves of all four pick-ups and compared results, but I was so shaken that I just sat down to think it over.

Is this experience typical of the pick-ups we are using, even the best of them, or was I very unlucky?

Probably a bit of each is the truth, but it does seem highly probable that many of us who fondly imagine that the name and purchase price of a pick-up has guaranteed us perfection are deluding ourselves, particularly if the pick-ups are more than about 12 months old.

For without doubt, a good pick-up should be able to trace a 1 Kc. square wave quite well, particularly when we remember that it came from a disc which had gone through normal recording and processing cycles, and was not artificially produced by test equipment as are the square waves used for amplifier testing.

And certainly it should not exhibit excessive ringing, as did some of those which I tested.

SUSPECTED PEAK

I must say that the results with the pick-up with the peak were not altogether unexpected, as I had originally made the check because I had begun to suspect it of having an edge which was not there when new, and it has had a very hard life under my hands.

What did shock me was to find that it had deteriorated to such an extent.

And if this happens to an unquestionably well designed pick-up, what on earth must happen with a poor one?

For that matter, how many recording engineers know what happens to their cutting heads when smacked with a rise time equivalent to that of a square wave?

I have asked that question in many famous recording studios of the world, and never yet seen an answer.

The answer would be, very simply, a few grooves cut with a square wave at 5 Kc.

If we had something like this to play around with, maybe we could get to first base in our efforts to get off the disc what can be put on to it.

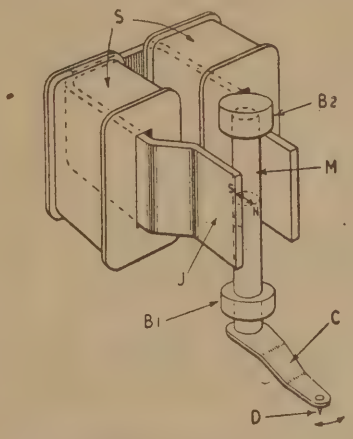
Referring again to the British Audio Fair, a recent Wireless World showed a working drawing of a new pickup cartridge made by Philips which appears to have great possibilities I saw one of these cartridges in Holland last year but they were not then ready for production

MOVING MAGNET

The interesting part about this pick-up is that the moving armature is actually the magnet in the system, and its vertical suspension and cantilever stylus mount give it a number of advantages at present enjoyed only by certain moving-coil types

The design has been made possible by the use of the lightweight, high-coercive, material Ferroxdure, which, when in cylindrical form as in this application, can be magnetised in a direction at right angles to the cylinder axis.

In the schematic illustration of the pickup shown, lateral movement of the stylus D is converted by means of the



Section drawing of the new Philips pickup.

cantilever C and the bearings B1, B2 into angular movement of the Ferroxdure magnet M. This induces an e.m.f. in the coils S wound on the magnetic material J in whose gap the magnet lies.

In this design the effective mass at the stylus tip is 3 mgm, the lateral compliance extremely high and the output 4mV per cm/sec recorded velocity The frequency response is flat from 30 c/s to 15 kc/s, the high-frequency resonance being at about 25 kc/s on vinyl discs.

Altogether this looks to be a most interesting pickup, and its appearance in Australia should be a popular one. At the moment I do not know when this is likely to be, although there are rumours that a complete player unit will soon be available here.

RECORD REVIEWS

VAUGHAN WILLIAMS — Romance for Harmonica with Strings and Pianoforte. Played by Larry Adler and conducted by Sir Malcolm Sargent.

ARTHUR BENJAMIN — Concerto for Harmonica and Orchestra played by Larry Adler and the London Symphony Orchestra conducted by Basil Cameron. Columbia 33S 1023.

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R-401: DICK STEWART SINGS— Alone Together; Walkin by the River: Ritual Fire Dance (instrumental): It All Depends on You: On a Little Street in Singapore: At Long Last Love: Time Was: Baia (Instrumental): Falling Leaves: The Glory of Love

R-602: HARRY ZIMMERMAN'S BAND WITH A BEA— Sentimental Journey On Wisconsin: Night Train: Alexander's Ragtime Band: I Love a Parade: The Breeze and I: Washington Post March: St. Louis Blues Washington & Lee Swing: Bugle Boy March (a Zimmerman Original).

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VLP-423: ERNEST BLOCH: ISRAEL SYMPHONY Franz Litschauer conducting the Vienna State Opera Orchestra and Soloists of the Akademie Choir (sung in English)

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PVL-7001: PROKOFIEV: CANTATA, OP. 78— ALEXANDER NEVSKY Mario Rossi conducting the Vienna State Opera Orchestra and Chorus, Ana Maria Iriarte, mezzo-soprano Russia Under the Mongolian Yoke Song about Alexander Nevsky; The Crusaders in Pskov: The Battle on the Ice: Field of the Dead: Alexander's Entry in Pskov

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It was an accomplishment which never failed to arouse my admiration.

Larry Adler has for years been a star of the musical hall with his amazing art and showmanship, but this is the first occasion I have ever heard music by two such distinguished composers seriously put together for him.

Both composers have shown that they appreciate all these facets of the mouth organ's armory.

The Vaughan Williams is well named a Romance — it is almost rhapsodical in its small way and very pleasant to hear.

Benjamin is more ingenious and enterprising in his exploration of the mouth organ, for quite obviously this is his main object. Nevertheless is it bright, neat and pointed music, the romantic second movement being much quieter than Vaughan Williams and in its way just as effective.

The recording is very good, and it is obvious that the microphone has allowed Adler to greatly increase his dynamic range over that which he could command in a concert hall. Long experience with mikes has undoubtedly made him a very skilful user of the same.

OUT OF THIS WORLD — A record of Earthquake and Ionospheric Noises recorded by Emory Cook. Long Play 5012.

This is a most extraordinary disc for those with a scientific turn of mind, or who like the unusual.

One side of it is devoted to recordings of earthquakes in various parts of the world, as recorded at the California Institute of Technology on a tape recording seismometer.

Because the frequency of the earth movements is so slow, most of these recordings are played 750 times original speed, at which most of them come through with the impact of thunderclaps.

Even so, some extremely low frequencies are included which make it a fascinating record to reproduce. Cook claims some sounds as low as 10 cycles per second.

One band records a movement too low in pitch to be heard, and with such recording amplitude that few pick-ups will stay in the groove. It is included so that you may watch your pick-up head describing a movement which, although speeded up, is virtually the same as that originally recorded by the machine in California.

Some of the qu es occurred as far away as Hawaii, some in Mexico.

The reverse side is made up of ionospheric noises in the form of bonks, swishes, whistles, tweeks, wandering whistles and a variety of combinations and derivatives, all of which represent the impingement of particle energy upon the ionosphere.

Many of these sounds, which can be received directly by a specially filtered audio system connected to a long aerial, are accounted for, but many others, including the "Dawn Chorus" of sounds which is greatest just before sunrise, are still enigmas, the unravelling of which may lead to profound discoveries about what goes on in outer space.

FRANCK — Symphony in D minor. Played by the Hague Philharmonic Orchestra conducted by Willem van Otterloo. Philips S 04011 L.

For those who do not like this symphony played with high colour and lush sonics, this performance will be in music to their ears.

It doesn't take many drooling performances to put you off it for life.

Van Otterloo, probably one of those who revolt against the purple treatment, has produced an extremely well tempered and intelligent version, not at all lacking in shape or sensibility, but completely free from any hint of exaggeration or affectation.

His tempos are faster than usual, but he does not hurry. He has simply decided that the music will not be allowed to drag, and it never does.

The recording is not particularly forward or brilliant, but it is well balanced and with a satisfying concert hall atmosphere. It is also very quiet and clean; there is a relaxed air about it which well suits a very creditable effort.

If I were to select a performance most likely to please most people, this might well be it.

SIBELIUS—Symphony No. 2 in D Major. Played by the Philadelphia Orchestra, conducted by Eugene Ormandy. Coronet KLC586.

There are many differences between this version and that of Anthony Collins, for instance.

Some of them are unexpected.

I was prepared to find the outlook much less arctic than Decca's record, for the Philadelphia doesn't operate too well at low temperatures.

I wasn't surprised, therefore, to find the music treated to many luscious moments.

But I was disappointed to find that, in the process, its shape and progression have been largely mislaid.

Frequently it becomes quite lumpy and disjointed, and the import of many phrases and modulations is not realised.

Collins, on the contrary, although he does posture a little, is never in any doubt about what he wants, and he gets it with a sharp clear line that is very rarely achieved by Ormandy.

The sound is much the same as that of recent Philadelphia records, which is a compliment, but it doesn't carry a great deal of impact.

But, as I have mentioned previously, the competition in Sibelius is really hot.

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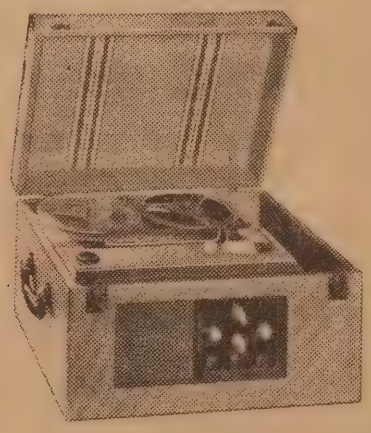

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KARAJAN'S CHORAL IS IMPRESSIVE

BEETHOVEN—Symphony No. 9 in D Minor; Symphony No. 8 in F Major. Played by the Philharmonia Orchestra, conducted by Herbert von Karajan, with Elisabeth Schwartzkopf, Marga Hoffgen, Ernst Haflinger, Otto Endelman and the Chorus of the Gesellschaft der Musikfreunde, Vienna. Columbia 330CX 1391/2.

After playing a recording of the Ninth I always have a feeling of disappointment, no matter how good it is.

I have listened carefully to every version yet released — some of them many times — and each time I have tried to analyse why I have not been happy.

Some of it is probably due to recording conditions.

Take this new one, for instance.

Immediately I notice it does not sound like the usual Philharmonia, for the best of reasons—it isn't playing in its accustomed place.

If the orchestra is to sound the same through all movements, it must be set up in a hall large enough to accommodate all the performers.

Man's ingenuity has not yet achieved recording acoustics which are magically superb for the orchestra alone, for orchestra plus choir, and for both with soloists, and to transport successfully the result into an ordinary room.

I freely admit that fewer jobs could be more difficult. Moreover there are sections of the choral part which are almost impossible to sing well, much less to record.

I have never yet heard a a performance in which the sopranos could cope with their part. Or one in which the soloists did not at some time appear to lose touch with each other.

It may, therefore, be more profitable to consider this new performance on a purely comparative basis, by which it comes out very well. More things go right with it, and fewer things go wrong.

Orchestral balance is one of its good points. The strings are rather prominent, but I used the N.A.B. setting, which improved things all round.

Karajan's tempos are fairly standard. In outlook he isn't as majestic as Toscanini, as meticulous as Scherchen, or as passionate as Furtwangler.

He has missed the full fire of the Scherzo (the drum beats are not taut nor the touch brisk enough) the slow movement is sometimes unimaginative, and joy of the final bars is rather mechanical.

The sopranos have been kept well in the background. This has reduced the shrieks but has given the choir an unusual quality. The soloists are all good and combine better than most.

Thus on nearly every count, these records do better than their opposite numbers, and for this reason alone it would be hard to deny it first place among the Ninths.

It plays cleanly and has a good surface.

The Eighth, which fills the fourth side, isn't particularly good, and is something of an anti-climax.

GREAT POWER IN COLUMBIA'S AIDA

VERDI—Aida with Maria Meneghini Callas, Fedor Barbieri, Richard Tucker, Tito Gobbi, Giuseppe Modesti, Nicola Zaccaria, Franco Ricciardi and Elvira Galassi, Orchestra and Chorus of La Scala, Milan, conducted by Tullio Serafin. Columbia 33-OCX-1319/20.

Of all operas, Aida has a special kind of power — something mixed up with the magnificence of the setting and the directness of its drama.

There is nothing complicated about the story; there are no tricks of Fate, which it is difficult to accept, or miraculous characters who solve their problems by virtue of unearthly powers.

Its interest lies almost entirely on the interplay of characters, one upon the other, their reactions to circumstances and the bludgeoning of Fate.

It is melodramatic, without a doubt, but it is the kind of melodrama which, in capable hands, rises to the level of high drama; a little unreal with the intoxicating colour of an ancient time, but convincing for all that. We never have reason to doubt that it could have happened.

Under the stimulus of a stage setting, we are ready to swear that, in fact, it did.

To make a successful recording, where the impact is through the ear alone, strong personalities and highly charged sound are necessary, and the presence of both is primarily why these new records are a success.

The cast, in fact, must be about as good as one could assemble for the job, each character being a recognised performer in the appropriate role.

As with most recorded operas of this series, Aida is built round Madame Callas, and it is inevitable, therefore, that much of your reaction will depend upon whether you like her controversial voice.

There is little doubt about her power to dominate the disc when she is on, either through the extraordinary effects she produces throughout her great range, or through her own vitality.

One has the feeling that her colleagues are giving an extra effort to make sure they are not over sung.

And there is little doubt she makes a deeply moved and passionate Aida, filled with dignity even through her distress, and so possessed with her character that she is unwilling to admit any limits to her resources.

In fact, the tendency to sing themselves out is a characteristic of all the major actors.

Very close miking has been rather deadly in exposing some roughness and vocal defects on Callas, Tucker, and Barbieri, but this is a small penalty to pay in exchange for such a telling performance.

I thought the honours were shared fairly evenly between these three, the latter being a very fine and well drawn Amneris.

But all the cast is good—orchestra and chorus as well.

If I could have removed some of the strange changes of voice by Callas (and a couple of her top notes!) and infused more of the genuine ring into the some-

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what husky tones of Tucker, I'd be willing to wager this Aida would be tops for a long time.

As it is, I thought it vigourous, musical, dignified, its drama well sustained and with an acceptable if not striking freedom from mike self-consciousness.

The engineering is clean, with some demanding high spots, and the sound is full and round. Surface noise little more than the faintest rustle.

Altogether, one of the most successful of operatic sets.

GUITAR SOLO — Music from Beethoven, Schumann, Chopin, Debussy, Massenet, Grieg and Sor. Played by guitarist Laurindo Almeida. Capitol P-8341.

Recording — very good, indeed. A certain amount of mechanical noise comes through which is pretty hard to avoid when recording a plucked instrument at close quarters.

The guitar is very good material for this kind of work, and produces particularly realistic results.

Musically its success depends upon how seriously you regard the matter.

Many items have been drastically altered in the process of transposition for the guitar, and naturally, it is difficult to adapt such a wide variety of music to an instrument whose very individuality bestows an air of sameness.

The executant, also, either prefers to play most of them slowly, or is unable to cope with a higher speed.

I can only say, therefore, that they are generally pleasant to hear, but no substitute for the original.

Only the classicists of the guitar will be disappointed.

DELIBES—Sylvia Ballet Suite; Coppelia Ballet Suite.
GOUNOD—Faust Ballet Music. Played by L'Orchestre des Concerts Lamoureux and L'Orchestra du Theatre Nationale de L'Opera, Paris, conducted by Jean Fournet. Philips S04013L.

Yet another Sylvia and Coppelia, and again with a French orchestra.

One advantage over its contemporaries is that it adds to these the Faust ballet music.

Which makes a great deal of ballet on a single disc.

All are brightly played, and not much seems to have been sacrificed to get so much on the record.

Certainly the top registers have not suffered — the triangles and other jingly instruments can be heard with more than average clarity.

Dynamic range may be down a little, but only once did I catch a suggestion of groove echo.

A nice disc, and a very good buy in quality and quantity.

TCHAIKOWSKY — Symphony No. 6 in B minor Opus 74. Played by the Leningrad Symphony Orchestra conducted by Jewgenil Mrawinsky. DGG LPM 18334.

An exceptional recording this. I don't think I have ever heard such blazing and vital fury as the Leningrad orchestra achieves in the wild moments of the first movement.

This mood is essential if the symphony's dynamic tensions are to sound as they should.

No array of other virtues can make up for the lack of it.

That tremendous explosion, so often fluffed by players or timid recording engineers, comes off with the impact of an H-bomb.

Only an orchestra of the highest precision and power could manage an attack so well.

To be super critical, there is a rather prominent echo — not unusual with DGG — which, although effectively concert-hall, does add an overhang which degrades the sharp lines of attack and the quality of quieter passages.

On the other hand it does blend the orchestra spatially, to give an impression of size which goes well with this symphony. It would be rather pointless to err on the other side and deny it enough "air".

A good example of this is found in the third movement, where the flexibility and vitality of the players shows up most impressively. The brass and cymbals, so often allowed to overweight the recording for sheer effect, are held well in check, so that we hear the orchestra playing as one body, without being blasted by one section of it.

The last movement could have exhibited its emotions less coldly in an otherwise tremendously effective performance.

You will note, again, the long time constant of the hall.

You will note, too, the extremely fine brass section, which, all through the exacting demands of the work, is outstanding.

The first movement contains some magnificent trombones.

All-in-all this is a very fine disc — probably the best "Pathetique" available

BEETHOVEN — Concerto No. 5 in E flat major Opus 73. Played by Robert Casadesus and the Philharmonic Symphony Orchestra of New York conducted by Dimitri Mitropolous. Coronet KLC 546.

The Emperor is probably the most popular of all Beethoven's concertos, both on recordings and on the concert platform.

When in London last year I heard it played by different people three times in one week, and there were a number of other performances during my stay which I did not attend.

All were well patronised.

By contrast, one of the last concerts I heard there featured Claudio Arrau playing Bartok, and despite a Tchaikowsky Symphony and the Philharmonic Orchestra it was just about the poorest house I can remember.

Casadesus, better known for his Ravel, makes a much better job of the Emperor than I expected.

It isn't a big performance, in the

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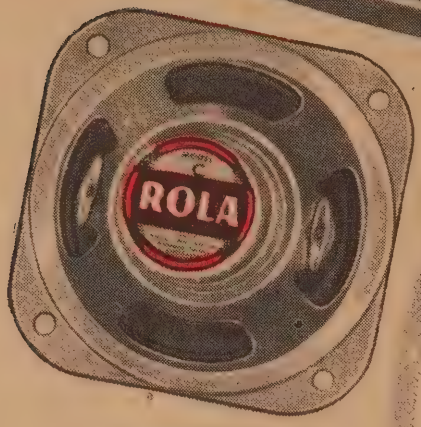

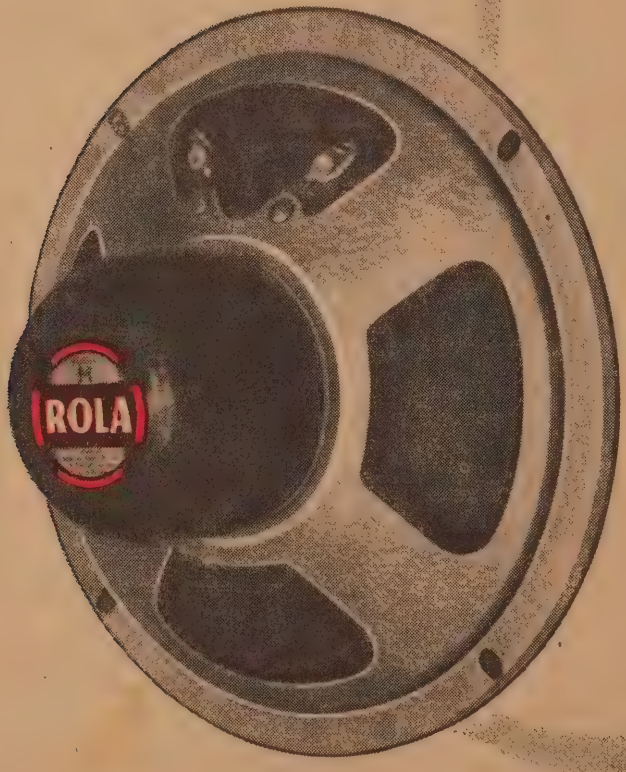

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Schnabel, Backhaus or even Kempf manner.

The nearest it comes to full size is in the first movement, but even here it is mostly straight up and down with more briskness and pace than subtlety.

In the second movement, the pianist hurries too much to catch the magic that is there, and in the last he gets only part of the possible contrast and interplay of ideas.

But he is deft and agile, a fine pianist, although there are times when his touch is not strong enough for the orchestra, which plays robustly throughout.

Generally speaking the piano-to-orchestra balance is quite good.

The recording itself is cut at moderate amplitude, rather remote and maybe a little light in the bass. The piano is quite clean, and is always pleasant to hear.

It's the kind of performance which, if you are not hopelessly addicted to the "old master" style, you might easily go for.

DVORAK — Symphony No. 5 in E minor Opus 95 (New World). Played by the RIAS Symphony Orchestra, Berlin, conducted by Ferenc Frisnay. DGG 18142LPM.

The first movement comes with a rush — an exciting performance which sets the pace for the whole symphony.

You may not like to hear it in such a hurry, for its drive (or overdrive) sends it skidding over many passages which are worth hearing more clearly.

In the rush at the end, the subject given out by the brass sounds dangerously like a Boy Scout's band agitato.

I would have liked the conductor to have dallied a little more here and there, so that the music could sing as it should.

The second movement is again fairly brisk, but Fricsay sees it rather sentimentally — he does not aim for that air of quiet stillness of which it can be such a lovely example.

In the third movement you will make special note of the effective explosions of the tympani which are extremely good wherever heard. This movement, too, is a good one to display the strength and weight of the players, their fine balance, and the wide dynamic range of the record.

The brass, too, is first rate.

The last movement continues the energetic progress of the first, and finishes up in a grand old row.

If I say that the whole thing bustles rather too much for me, that its changes of pace and dynamics are too uneven, and that there isn't as much tuneful ingenuity as I would like, that's only a personal opinion.

It's a bright, full-blooded disc, which sounds well in a clean, reverberant way, recorded with plenty of punch, and likely to appeal to many. One of DGG's best examples of orchestral recording.

OFFENBACH—Gaite Parisienne Ballet Music (complete). Played by the Philadelphia Orchestra conducted by Eugene Ormandy. Cononet KLC 552.

This is one of the best Philadelphia records I have ever heard.

The sound is rich and full, with a great presence that never grows oppressive.

Dynamic range is very great, all the more impressive because the surface is almost completely quiet.

Its frequency range is in the hi-fi class, but the tops have been carefully controlled to avoid any shrillness or edge.

The orchestral playing is exceptional; beautifully balanced, flexible and brilliant.

It is scarcely necessary to say much about the colourful music, excerpts from which are always cropping up in light music sessions. Everybody likes it — it has the same immediate appeal as that of a Strauss waltz.

It comes in a most attractive folder with a striking cover design, and much interesting and instructive matter about the ballet.

It rates the five stars.

BEETHOVEN — Sonata No. 23 in F minor Opus 57 (Appassionata); Sonata No. 32 in C minor Opus 111. Played by Julius Katchen Decca LXTA 5187.

The more difficult the music, the better Katchen seems to play.

Here he attempts two famous and most important Beethoven sonatas; the Appassionata from his middle period, the Opus 111 from his last.

It was, in fact, the last big piano work he ever wrote, and perhaps his finest.

We could seriously argue whether the last movement is not the best to be found in all his piano music.

It has a quality all its own. It sheds the immediate confines of notes and of instruments, and projects what it has to say so directly from mind to mind that technique becomes merely a method and music a medium.

Katchen's Appassionata is a powerful and masterly version, quite free from mawkish exploitation or pedantry.

Its outlines are appropriately massive, its texture is explored with scholarship and interest, it is lively and enterprising without damage to its sincerity.

In the Opus 111, Katchen's vigour and impetuosity are perhaps a little too much in evidence when compared with the more classical performances of Schnabel, Petri and Gieseking. But this is a young man's Beethoven and it is good to hear it. I found his performance profoundly impressive.

The piano recording is good, even in its most forceful passages. Its presence I thought just right, although the tone is rather hard until you get used to it.

This disc would be my first preference for both these sonatas. I class it with the earlier Diabelli variations as some of the best Beethoven on records.

The surface is first rate.

DEBUSSY — La Mer. Played by the Philharmonic Symphony Orchestra of New York conducted by Dimitri Mitropolous.

ROY HARRIS — Symphony No. 7. Played by the Philadelphia Orchestra conducted by Eugene Ormandy. Coronet KLC 561.

La Mer is the most brightly coloured of all the versions I have.

The music is highly programmatic—it was intended to sound like the sea, and it does.

I wonder whether the glorious Technicolor is overdone?

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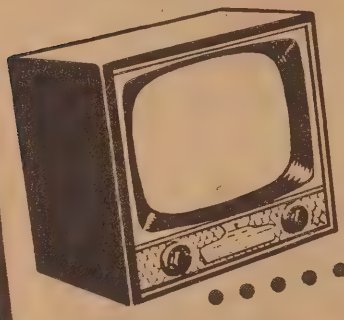

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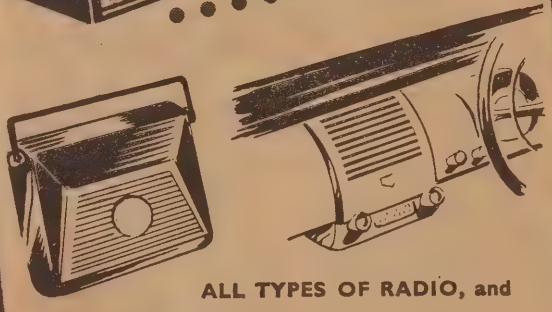

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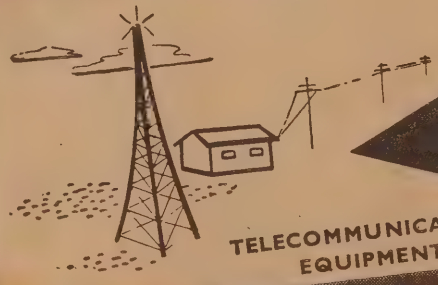

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Toscanini, for instance, does not attempt to glamourise the scene with as much glow.

His orchestra does not snatch at a phrase, or invest in so many sudden dynamic adventures.

His approach has a colder, more subtle air to it. He paints clear and vivid pictures to be seen and marvelled at—Mitropolous adds 3-D, and warms them up for audience participation.

It is inevitable, therefore, that we should be so often listening to a brilliant trumpet, or the sweep of strings, or a piece of woodwind. These things are equally beautiful for Toscanini, but we hear them only if we listen for them; they are too much part of the whole to be important of themselves.

If you are interested in the comparison, play the last inch of each disc one after the other.

In style, both conductor and orchestra are well suited to the contrasting rhythms of the Harris 7th Symphony.

Those who remember the first recording of his 3rd will recognise immediately much of the same idiom and orchestral division that made that symphony such an exciting thing.

But I don't know that this one is a better work. As it progresses, you might recognise it as more or less a variation of the same manner. Its angry noise is stimulating, and the Philadelphians, who first played it in 1955, can probably do it better than anyone else.

BORODIN — Polovtsian Dances, In the Steppes of Central Asia.

IPPOLITOV-IVANOV — Caucasion Sketches. Played by the Philharmonic Symphony Orchestra of New York conducted by Dimitri Mitropolous. Coronet KLC 547.

The recording is bright — it has good body — the balance exhibits the orchestration to advantage, and it is forward enough to be quite brilliant.

It plays well, particularly if you have some power to spare. I'd like more abandon in the Polovstian Dances; they sound more like a rough-and-tumble than the wild things they are.

"In the Steppes" is done well, the recording being a little too close to allow a really distant fade-out.

The "Sketches" have a straight forward commencement, rather spoiled on my copy by too much surface noise. They improve as they go along, and end up in great excitement.

A good record. Plays best with an extra notch of bass boost, but is commendably free from the edge which so often spoils American discs.

Use the RIAA curve.

SCHUMANN — Carnaval Opus 9 — Fantasie in C Major Opus 17. Played by Robert Casadesus. Coronet KLC 583.

These are hard driven versions, on the whole, of works which are neither hard nor capable of being driven.

The playing is crystal clear, deft, and often quite beautiful.

Sections of the Carnaval and the Variations are better for bright treatment, but very little of the traditional poetry is left to the others.

Which is strange, because the pianist is quite capable of playing them as most of us hear them in our own minds.

If this approach is through a desire to avoid orthodoxy, then you must judge it on its merits.

But to me it does sound as though Casadesus isn't altogether compatible with Schumann.

The recording shows the piano on the hard side, not too forward, and with ample power.

The surface has some faint crackles which might be a nuisance on wide range gear.

MENDELSSOHN — Violin Concerto in E minor Opus 64.
MAX BRUCH — Violin Concerto in G minor Opus 26. Played by the Pittsburgh Symphony Orchestra conducted by William Steinberg. Capitol P 8243.

Both these concertos suit Milstein. He is a rock steady violinist, with an intonation so good that you notice it, and a firm, fine tone.

He does not often give forth with great power, but neither of these two concertos needs it.

The Max Bruch satisfied me as it rarely does. The orchestra was largely responsible for this, as it shapes the music and handles it with a simple intelligence that keeps our interest.

As the jacket points out, the work is really a second movement with a prelude and a coda fore and aft, and it was the firm manner in which this is emphasised which impressed me.

Milstein's handling of the slow movement is a nice balance between strength and sentiment, with probably fewer affectations than in any other recording.

The Mendelssohn is good, too, although I would have liked more dash in the final movement which diminishes to quite a small stature near the end — small at least in contrast with earlier passages, for there is quite an impressive and virile body of sound on this disc.

There are now too many versions to undertake a detailed comparison between them, but Milstein combines most of the good things of the others to produce one which will I am sure be acceptable to all.

Certainly you would have to split the coupling to better either side.

The recording is smooth rather than brilliant. A touch of top cut might take a slight edge from the violin. The surface seems OK.

BRAHMS — Symphony No. 4 in E minor, played by the Philharmonia Orchestra, conducted by Herbert von Karajan. Columbia 330CX 1362.

The first movement is rather slow in starting, but it is a fine disc and a fine performance, improving with each movement until, at the end, everything is first class.

The first movement disappointed me initially. There seemed little enthusiasm from orchestra or conductor. Even with several check-backs, I still think it could have been done again, when all concerned might have been in better mood.

Like most Karajan performances it is free from any extremities or conceits; touched with dignity, brisk but unhurried.

Its the kind of reading most people will like, and which will wear well.

The Philharmonia is, as always, firm and well disciplined. Its sound is full and clean.

There are several very good Fourths, but this one is in the front rank.

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SHORT-WAVE NOTES BY ART CUSHEN

RARATONGA HAS MOVED TO 4965Kc

Raratonga Radio in the Cook Islands is at present being heard on the new frequency of 4965 Kc. during the Thursday broadcast.

THE transmissions from the Cook Islands are being heard in New Zealand where the programs from ZK1ZA are being received.

This station has been operating on 5050 Kc. for some months but has recently moved to 4965 Kc. It has a regular transmission on Thursday from 2.30 p.m. and this broadcast generally lasts for one hour. School brodacasts are also released, but these are irregular.

According to a report from the Pacific Island Monthly the Raratonga station broadcasts over the station of the Cook Island Administration. The frequency change was made on May 1.

The transmitter is located at Black Rock on the north west coast of Raratonga Island and program material is all tape-recorded by the Social Development Department, prior to the actual broadcast.

The tapes are handed over to the Radio Department for transmission through a transmitter which is also used on other frequencies for telegraphic communication to overseas at other times.

No funds have yet been made available by the New Zealand Government for the establishment of a proper broadcasting station, but there has been a suggestion, as an interim measure, that a more frequent service might be operated through a privately owned amateur station, the operator of which also has a commercial broadcast licence.

Radio Raratonga has been heard in New Zealand at good strength during the Thursday broadcast from 2.30 p.m. It broadcasts a lengthy list of shipping activities at Raratonga at 3.10 p.m. and this is repeated in the local native tongue. The station closes at 3.15 p.m. when this announcement is given: "Well there we must say goodbye — will be on the same time next Wednesday evening, when we will bring you more information news and entertainment from Raratonga. Until then, goodnight."

An island musical number follows and at 3.15 p.m. the transmitter announcer signs the station off the air with this identification — "This is ZK1ZA Radio Raratonga, owned and operated by the Cook Island Administration. Be listening to this station again next Wednesday."

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RADIO RANGOON

The new high powered transmitters of the Burma Broadcasting Service at Rangoon, have been heard by listeners in Australasia and the Near East.

This 100,000 watt transmitter, the first of several to operate on both short and medium waves, has been heard on the 11764 Kc. channel carrying the normal Home Service programs from Rangoon. It has been noted on the air from shortly after opening, with a test period at 9.40 p.m., and then with normal programs at 10 p.m. to sign off at 1.15 a.m.

The first portion of the service from 10 p.m. to 12.15 a.m. is in Burmese and the last hours transmission is in English with news at 1 a.m.

The station uses a drum beat interval signal from about 9.40 p.m., and shortly after this, the station has uninterupted light music to 10 p.m. when the normal transmission is commenced.

The program in the English hour generally consists of light music. Interference from the nearby Courier channel of 11765 Kc is the main deterent to excellent reception in this area.

The Rangoon station when closing at 1.15 a.m. gives a program summary of the next days transmissions in English, all of these are carried on the only two frequencies now in use, 11764 Kc. in the 25 metre band, and the medium wave channel of 955 Kc.

The second transmission is 5.15-5.45 p.m., and this includes news at 5.30 p.m.

The news session is generally announced by a male speaker and other announcements by a lady speaker. The program summary at 1.15 a.m. is followed by the sign off with the Burmese National anthem.

XEOJ ON 11860 KC.

FIRST reported by listeners in the United States as being received at 12.30 p.m., a new Mexican station has been identified by us as XEOJ. This station, because of severe side interference from Berne Switzerland, defied identity by American listeners, but a recorded sign off at 4 p.m. was made and we were able to identify the announcement as "XERJ ondas larga 1320 kilocycles en XEOJ ondas cortas 11860 kilocycles."

The station is operating from Mazatlan in the province of Sinloa, Mexico. The 1320 kilocycles station operates with 1000 watts day and 500 watts night.

DXB3 COTABATO

THE strong signals of the new DXB3 Cotabato, Philippines has been reported by listeners on both sides of the Tasman. This station operates on 3945 Kc. and has been heard from 7.00 p.m. to midnight. The station announces as "This is the Notre Dame Broadcasting Corporation. Radio Mindanao, broadcasting on stations DXMS 880 kilocycles, and DXB3 on 3945 Kc. and broadcasting from Cotabato, Philippines."

The station broadcasts both commercial and Catholic religious programs and carries a program review at 8.25 p.m. and a news bulletin at 10.30 p.m.

NOTES from readers should be sent to Arthur Cushen, 212 Earn Street, Invercargill, N.Z. All times are Eastern Australian.

STATION FOR TONGA

NEARBY Tonga is also soon to have a station, as a member of the New Zealand Broadcasting Service has been investigating the technical facilities necessary at Nukualofa, the capital on Tongatabu Island.

This station has been mooted for several years and would almost certainly use one of the tropical bands, 5000 or 6000 Kc, as favoured by the Island stations. There may be also a medium wave outlet for local coverage.

Tonga and the New Hebrides are the only major groups in the Pacific without a radio service.

FLASHES FROM EVERYWHERE

RADIO GOA in Portuguese India is to install three new transmitters according to a Portuguse Press report, which states that one 50,000 watt transmitter will operate on shortwave and two 25,000 watt transmitters on the broadcast band.

Mexican XEXE on 11900 Kc. is again active, but this station, as in common with all the relays of the XEX chain are never reported as being in the habit of verifying.

OKINAWA relay station of the Voice of America has been noted on several new frequencies from opening at 6.30 p.m. when the station has been using 17830, 15380, 11830 and 9635 Kc.

The station has been observed continuously on these channels to sign off at 2.30 a.m. The Courier transmitter of the Voice of America at Salonika has been noted 15165 Kc. instead of the listed frequency of 15195 Kc.

ANGOLA station, Radio Club of Luanda at Nova Lisbon, has replied to a Cyprus listener that the station operates on two frequencies, and the schedule is 4.00-5.00 p.m., 9.00-11.00 p.m., and 3.30-7.00 a.m., daily. On Sunday the schedule is 4.00-8.00 p.m., and 12.30-4.00 a.m. on Monday morning. The station is using CR6RQ, 7152 Kc, and CR6RD on 4854 Kc.

RADIO ZANZIBAR, in the East African colony has been heard in the Middle East on two frequencies, 3339 and 4795 from opening the program at 4.30 a.m. The lower frequency proved the weaker signal when tuned in Cyprus.

VENEZUELAN signals in the 31 metre band are reported by Stuart Morris of Victoria, who mentions that both YVXJ on 9505 and YVMZ on 9530 Kc. both opening at 8.30 p.m. Our observations here show that YVMZ at Maracaibo, using the slogan "Radio Popular" is much the better signal. It opens with the Venezuelan anthem and then news items interspersed with commercial announcements. The YVXJ Radio Baraquisimento station is mixed both with the Manila and Dixon California stations on nearby channels and is much harder to hear, but has a similar type of program.

BOLIVIAN station Radio Illimani, The Voice of Bolivia, has been providing good signals on 9555 Kc. from opening at 9 p.m. and this station is the only reliable signal from this seldom heard country. The station opens with an organ melody and the sign on announcement is generally read by a lady announcer, and the program following is of popular Latin American melodies.

ROUMANIA has added the 19 metre band for its North American service, in the program from Bucharest. The station is using the old frequencies of 9570 and 11937 Kc., as well as this new 19 metre transmitter on 15373 Kc. The station has news with good strength at 1 p.m. and 2.30 p.m.

BRAZZAVILLE transmissions to the Far East are being reported on 17879 Kc., from 11.30 p.m. to 1.15 a.m. English programs are from 12.30 to 12.45 a.m., and reports from the North American area state interference is present on the channel from WLWO, on 17880 Kc., opening on the frequency at 1 a.m.

HAITIAN transmissions in the 13 metre band have been reported from several areas, but the latest report from North America has clarified the position. The 4VWI transmitter of the Evangalistic Voice of the West Indies is at Cap Haitian in Haiti. The station is using the 21540 and 21525 Kc. The former transmitter has a V beam covering Europe and the South Pacific. It operates on Sunday and Monday 6.00-9.45 a.m. on 21525 Kc., and on Sundays from 8 p.m. to midnight on 21540 Kc. Reports are requested to Box 1, Cap Haitian, Haiti.

AFRS SCHEDULES

THE Armed Forces Radio and Television Service at Los Angeles, has increased the daily schedule to 14 hours, now operating 11.00a.m.-1.00 a.m. The new schedule has news each hour except when carrying baseball 1.05-3.00 p.m.,and8.05-10.00 p.m.

A new transmitting schedule included the use of the main A.F.R.S. channels, on a revised timing. The new schedule is:-

K.C.B.R.-1 (15125) 11.15 a.m.-4.15 p.m.
K.C.B.R.-2 (21630), 11.00 a.m.-5.00 p.m.
K.C.B.R.-2 (9700), 5.30 p.m.-1.00 a.m.
K.C.B.R.3 (17850) 11.00 a.m.-5.00 p.m.
K.C.B.R.3 (11870), 5.30-1.00 a.m.
KCBR-5 (15315), 11.00 a.m.-4.00 p.m.
K.C.B.R.-5 (9570), 4.30-10.00 p.m.
K.C.B.R.-5 (15315) 10.15 p.m.-1.00 a.m.

The program which gives the information as to program and schedule changes is released each day as 11.15 a.m. and 5.45 p.m., while on the 1st and 15th of each month a program giving the complete program content for each day and the frequencies in operation is carried by A.F.R.T.S.

THE HAM BANDS WITH BILL MOORE

Official station of the N.S.W. Division of the WIA, VK2WI, will be able to perform a valuable service to amateur radio by disseminating news and to the public in emergency from the new site and with its higher powered transmitters.

A MAJOR event in Amateur Radio history in N.S.W. took place in May with the official opening of the VK2WI transmitter house and site by the Minister of the Interior, Mr. Allan Fairhall.

Some 300 persons attended the largest gathering ing of amateurs and their families yet assembled in that State.

N.S.W. WIA president Jim Corbin, VK2YC, welcomed the guests and visitors on behalf of the Division and outlined the objects that led to the acquiring of the site and the building of the transmitter house.

It will serve a threefold purpose according to the president — to disseminate WIA news, as a control station for work in emergency and as an adjunct to Civil Defence communication.

He explained that the erection had been carried by the volunteer effort of members and had been financed from Institute funds and from donations that amounted to over £1,000.

Jim then introduced the Minister. Mr. Allan Fairhall, M.H.R., VK2KB, whose opening remarks emphasised the value of the movement to the community in peace and war.

The Minister mentioned radio amateurs' work in pioneering the high frequencies and referred particularly to their record in World War II.

THE RAAF RESERVE

Mentioned specifically was the amateur's R.A.A.F. Wireless Reserve, whose members were called up immediately on the outbreak of the war and provided a valuable addition to the signals staff.

Mr. Fairhall also mentioned the work of amateurs in emergency during flood and bushfire with special reference to the assistance rendered during the State-wide floods of 1956, he said that the amateurs on the North Coast of N.S.W. had built up a fine record of public service.

The Minister said that amateurs would have to be fully organised to meet the demands that are certain to be made on their exclusive frequencies by other services. He suggested that amateurs should fully support the WIA and so secure effective representation in official circles.

Mr. Fairhall then declared the VK2WI building officially open.

Police Superintendent Wal Salmon, VK2SA, then spoke on the value of the hobby as a training ground for youths and some of the problems of juvenile deliquency.

He described too the earlier work on N.S.W. Police Wireless organisation carried out by amateurs — an interesting summary of the original experiments.

Other speakers included Mr. Robertson, Deputy Controller of Civil Defence in N.S.W. who covered the possible work of amateurs in CD communications and Colonels Lawrence of Army Signals pointed out the invaluable work of amateur communications in the first stages of any emergency.

Guests also present were Mr. Allan Grant, C.D. Communications Co-ordinator for N.S.W., W./C. Harvey, Home Command, R.A.A.F., Penrith, Sgt. Bert Glasscock, VK2ZI, Officer in Charge Police Wireless and Mr. Lionel Todd, VK2LS, representing the Superintendent, Wireless, N.S.W.

Five old-timers of World War I vintage seen comparing notes were Chas Maclurcan, VK2CM, Joe Reed, VK2JR, Jack Pike, VK2JP, Wal Hannam, VK2AXH, and a previous secretary of the Division Malcolm Perry.

Two country amateurs who travelled the longest distance to be present were John Field, VK2AQF, of Deniliquin and his wife and Rod Pike, VK2ACU, of Coonamble.

Many amateurs and associates contributed toward the VK2WI home, either by contributions or voluntary labour, or both.

On the opening day councillors and members worked hard to ensure that visitors were suitably entertained but all will agree that Harry Pickett, VK2AHP, Ed Hulme, VK2EN, and Engineer Dave Duff, VK2EO, should be congratulated for their efforts.

OPENING BROADCAST

The whole of the opening ceremony was rebroadcast by VK2WI on 7146 kc/s and was of particular interest to country members. The net organisation of VK2WI was demonstrated to the guests when stations throughout N.S.W. answered spot calls. Full co-operation was accorded by all country amateurs.

The Minister also spoke over VK2WI and at the conclusion of the ceremony afternoon tea was served.

The VK2WI transmitters are located on a 5 acre block 700 feet above sea level at Dural, 20 miles north-west of Sydney. The building comprises two large rooms. One houses the transmitting and receiving equipment, and the other is suitable for entertaining complete with built-in table, and running water. The transmitting equipment is impressive and covers all bands 3.5 mc/s through 144 mc/s.

The main transmission is radiated on 7 mc/s and on this band an AT14 — parallel 813's running 450 watts input to a half wave dipole fed with co-axial cable is used. A similar antenna is operated on 3.5 mc/s where the transmitter runs push-pull 807's.

FINAL AMPLIFIERS

In the transmitters 14 mc/s to 56 mc/s the finals range from push-pull 813's to 829's on 28 and 56 mc/s. The last three bands are not used currently and the third transmission normally takes place on 144 mc/s where an 829 running 85 watts feeds a four stack turnstile.

This antenna is nearly 70 feet high fed with a 300 ohm ribbon and coverage up to 180 miles has been recorded. At the moment the receiver for the HF bands is an AR7.

The major problem experienced to date during operation is varying mains voltage, at times as low as 90 volts, and a variac allows transmission only on occasions. The local supply authorities have promised to improve the available voltage.

With the completion of all tests VK2WI will certainly be able to effectively cover N.S.W. during any operation.

NEW DX AWARD BASED ON AMATEUR PREFIXES

AN entirely new type of D.X. operating award has been instituted by the C.Q. Magazine. It is the W.P.X. (worked all prefixes) award and is available to licenced amateurs throughout the world who have made radio contacts with 300 or more different radio "prefixes".

A prefix for the purposes of the award is the "two or three letter/numeral combination which forms the first part of any amateur call."

For example W2, K2, KN2, 5A1, 5A2, DJ1 and DL1 would all be considered different.

There is no question of countries and the controversial question of what should constitute a country and what should not is bypassed. VP8 a prefix covering some recognised countries would only count as one prefix for the purposes of the award.

Applicants for the W.P.X. must submit a list giving the call-signs of the stations worked followed by the date of the contact and must be in possession of the Q.S.L. cards or other proof of contact before submitting the list. C.Q. reserves the right to examine all Q.S.L. cards.

All contacts must have taken place since January 1957.

In addition to the basic awards for working 300 prefixes stickers will be available for one band working. In all 8 basic awards will be available, W.P.X.-phone, W.P.X.-C.W., W.P.X.-S.S.B, W.P.X.-M. (mobile), W.P.X.-A.M. (aero-nautical mobile), W.P.X.-M.M. (maritime mobile), W.P.X.-T.S. (transistor Q.S.O.'s).

VP8AP should be operating as VP8SP from Cargados Carajos a dependency about 250 miles N.N.E. of Mauritius in August. He will run approximately 12 watts input on the 14 mc/s band. This one could easily be rated a new country.

The following procedure has been suggested as the most effective manner to ensure Q.S.L. cards arriving at their destination in the U.S.S.R. A well known U.A.3 offered the suggestion. On receiving a Q.S.L. card from U stations forward the card direct to the address shown thereon.

If sending cards via Box 88 Moscow, do not show callsigns or other radio data on the envelope, just the address as above.

Currently in the news is the unfortunate floundering during rescue operations of the "Tahiti Nui" the raft that by design was drifting from the Pacific Islands to the coast of South America.

Operators from the raft using the call FO8AP/MM have been quite active on both the 14 and 28 mc bands. 16 I.R.C.s are sufficient to obtain a three colour map of the expeditions' route and other features of the trip. Address requests to F8TM Rex BP42.01, Paris, R.P., France.

Propagation research

THE A.R.R.L.-I.G.Y. Propagation Research Project started off on schedule last September. The special A.R.R.L. staff engaged is paid under contract to the Department of the Air and will continue to be employed by that Department for the duration of the Geophysical Year, concluding at the end of 1958, or for a longer period if the investigations require it.

Over 800 amateurs in all parts of the world have already signified their intention of participating.

These amateurs have been requested to forward reports twice monthly, a list of stations worked and heard via ionospheric propagation modes on the bands over 50 mc/s. They are asked also to report times of operating or listening with no results. These are known as positive and negative reports respectively.

The main types of propagation on which information is required are trans-equatorial scatter, long North-South Contacts, paths crossing the equator especially with openings at the "wrong time."

Sporadic E skip, Auroral and meteor scatter and news of F2 openings are also required for conventional skip and back scatter variety. All these modes of propagation involve the ionosphere and most of their uses for practical communication were found by radio amateurs.

The project runs its own publication for issue to registered observers and is now used mainly for instructional purposes but later news of VHF activity and reports sent in from the various observers will be included.

READY FOR JULY 1

The trial run on observations commenced on January 1 and the whole scheme should be in full force by the time of the opening on July 1 of the Geophysical Year.

As each report is received it will be inspected and evaluated, and additional information such as latitude and longitude of the station added. Reports will then be sent to an operator who will prepare punched cards showing all pertinent information. The process will list all data received for high speed automatic sorting and summarising at a later date.

It is anticipated that the peak periods for I.G.Y. activity by radio amateurs should be in the periods of October and November this year and January and February of 1958.

In the U.K. the Radio Society of Great Britain has appointed two co-ordinators for I.G.Y.-D.W. Turby, G3EOH, and G.M.C. Stone, G3FZL. It is proposed to name Area Activity Co-ordinators whose responsibility it will be to organise particular areas and assure that the different study aspects are covered. The general plan is still in the embryo stage.

Locally amateurs are already active with the I.G.Y. project in co-operation with the Sydney Amateur Astronomers for whom they will make radio observations on the track of the world satellites, one phase of I.G.Y. amateur working.

Four converters have been constructed and they will be located in country and city areas. Hugo Stitt, VK2WH, Forbes, and Neville Wilde, VK2DR, Blayney, will be the country observers with John Miller, VK2ANF, and Bob Godsall, VK2ARG, in Sydney. They expect to use four element yagi arrays for receiving.

CO-ORDINATOR IS VK2HO

Roy Hart, VK2HO (recently returned from the Civil Defence School at Macedon) will be the co-ordinator and he will report satellite progress from the four stations to the observing post of the amateur astronomers at Belfields, Sydney.

At this post Harry Lapthorne, VK2HL, assisted by other amateurs, will assure that the warnings are received from VK2HO and broadcast over loudspeakers to the observers ready to train their telescopes on the satellite.

The whole object of the scheme is to provide some warning of the satellite's approach to the amateur astronomers.

The antennas of the listening post stations will be facing west and as soon as the satellite comes over the horizon they will transmit a warning via the net. It is expected by this means that about one minute warnings of the satellite's approach will be given.

Project Vanguard, the official name of the operation will commence when a 72 foot high rocket will be launched at Cape Canaveral, Florida. Out of the rockets nose the satellite, a magnesium sphere, will be ejected by a charge at the correct height.

The estimated time the satellite, 20in in diameter and 21.5 pounds in weight will remain in orbit varies greatly, but it will circle the earth every 90 minutes.

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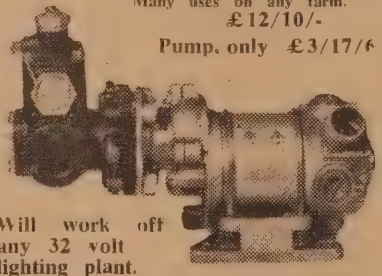

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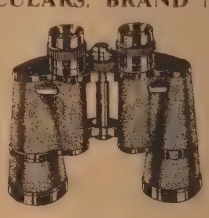

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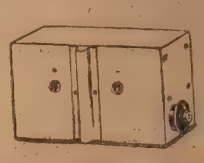

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CONDITIONS ON 144 MC

THE 144 mc/s band provided some good conditions in late May when Ian Berwick, VK3ALZ, in Melbourne and Hugh Stitt, VK2WH, exchanged signals on the band over 350 miles. Jim Edge, VK2AJO, who was at Forbes at the time bears witness to the fact. Previously Hugo had identified signals from VK5BC, and VK5MT portable Mt. Lofty, the first time signals from South Australia have been heard in N.S.W. The distance is 600 miles approximately.

Don Haberecht, VK2RS, is currently testing out a new antenna for 144 mc, a five element Quad.

American stations finally made contact to Southern Africa on the 50 mc/s band in March. The Africans were well known stations ZE2JE Southern Rhodesia and VQ2PL Northern Rhodesia and they QSO'ed a number of W stations.

During the same period, against all recorded predictions, the band opened to South America with prefixes CE, LU, OA and PZ being contacted.

COMMERCIAL INTERFERENCE

VARIOUS methods of reporting upon and acting against the ever increasing number of commercial and broadcasting stations operating within our amateur bands have been suggested. Some time ago the R.S.G.B. proposed to the British G.P.O. that a selected group of members should be permitted to notify one of the G.P.O. monitoring stations by telephone wherever a spasmodic broadcasting or commercial "intruder" is heard in the exclusive amateur bands.

The Society felt that this method would enable the Post Office to take effective action by reporting intruders to the I.F.R.B in Geneva immediately.

The G.P.O. feels that the proposal would not be of real benefit and explained that there is a technical difficulty due firstly to the fact that the offending station might not be audible at the amateur's location and that of the monitoring station.

Secondly that amateur stations being specifically designed for reception in a limited band and are more sensitive than the Post Office Monitoring stations in that particular band.

The Post Office points out that the majority of the interference which the Society complains about comes from abroad and the only action that they can take is to register a complaint about it.

The Post Office have therefore suggested that the Society would contribute more effectively to the safeguarding of the amateur bands by concentrating on completeness of information rather than on speed of communicating with the Post Office. The authorities will act only on reports of continuous interference rather than sporadic cases.

The Council have decided to invite members to provide complete logs of interference that continues over several weeks, a similar system to that recommended here in Australia.

The greatest problem confronting amateurs that make these types of reports is the indentification of stations heard, broadcasting stations excepted. The worst cases generally heard are from automatic code stations that seldom transmit their calls.

It is a task of value to the movement but few amateurs appear to have time available for station identification.

V.H.F. NEWS

IN the Hidden Transmitter searches of the N.S.W. V.H.F. and T.V. section Eric Dickson, VK2AFM, was the only station to locate the transmitter. The usual "Hot Dogs" and Tea were served to the remainder when they finally were assisted home.

The Sunday event saw Bob Winch, VK2OA, and Jim Cumming, VK2ZBD, tie in a progressive search.

The section will make special preparations to observe conditions on the 144 mc/s band to Victoria and South Australia between July 16 and 31.

A meteor shower is predicted between those dates and all country V.H.F. amateurs have been notified of the fact. Although most recorded work of reflected signals from meteor trails has been carried out with high power equipment, some results have been noted with medium power equipment and the section urges amateurs to look out for short bursts of signals from the south during this period.

Two types of signals reflected from meteor trails are usually observed. The first is from a meteor trail which does not cause a high ionisation density. From this type "pings" of signals lasting up to two or three seconds are heard and this is the more usual type of reflection occuring.

The second is from an over-dense trail and signal strengths are comparatively constant for a period of up to two or three minutes.

A comprehensive study of V.H.F. Meteor Scatter Propagation is provided in an article by Walter Bain. W4LTU, in the April 1957 issue of Q.S.T.

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The Overseas Telecommunications Commission operates Australia's overseas communications services through two main telegraph offices, five cable stations and six international radio stations, in addition to the Coastal Radio Service through 23 stations around the coast of Australia and in Papua/New Guinea.

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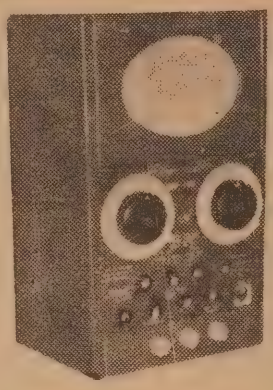

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1J6	12/6	39/44	10/0
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£1/7/6 BASES 10/- extra.

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17 valves 100 to 156 Megs Complete with valves
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200 Watt P.A. Amplifiers

805 P.P 240V A.C Power Output matched to 100V
£47/10/-

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24V. 100MA. BRIDGE, ideal for trickle Chargers. Relay operation etc
2/9 ea. **25/- doz.**

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24v 6 amp full wave
£4 ea.

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Fully filtered. 250V 60 MA Output & 6V. 2.5 Amp. Secondary.
£1/17/6
12V Model as above
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8 VALVE RADIOGRAM HI-FI CHASSIS

Dual wave, bass & treble boost tuned R.F. stage 12" speaker.

£28/17/6

5 VALVE RADIOGRAM CHASSIS

DUAL WAVE 12in SPEAKER

£18/15/-

5 valve also available as home constructor's Kitset **COMPLETE WITH CIRCUIT £14/15/-**

7 VALVE DX RECEIVER

3 band, 2 to 6 to 18 megs 160 to 16 metres and broadcast. Exceptional selectivity sensitivity 2 microvolts. **NEW AUSTRALIANS,** listen to European short wave stations.

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PUBLIC ADDRESS RANGE 240-AC

6 Valve 10 watt **£14/17/6**
6 valve 25 watt **£25/7/6**
6 valve 40 watt **£32/7/6**

BATTERY ONLY OPERATION

6 valve 6 volt 10 watt **£18/15/-**
7 valve 12 volt 10 watt **£19/15**
7 valve 12V 25 watt **£24/17/6**

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6 valve 10 watt 6V. **£20/15/-**
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7 valve 25 watt 12V **£29/7/6**

HI-FI RANGE

MULLARD 5/10

£34/15/-

Complete with Jensen twin cone speaker, Ferguson O.P transformer, 301 & U.L. taps.

MULLARD 5/20 AS ABOVE

£42/15/-

Tuner & separate control box with mike, pre-amplifier.

£12 extra

THE FINEST SET AT ANY PRICE

CHECK THESE EXTRA FACILITIES

Built-in Preamplifier to suit crystal microphone tape deck, electronic guitar, sound on film TV, etc.

Hear it demonstrated on these units

DEMONSTRATIONS EVERY SUNDAY 2 to 5 p.m.

OR EVENINGS. BY PHONE APPOINTMENT AT COLLAROY

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CABINETS AND ALL ACCESSORIES TO SUIT

THE OUTSTANDING 10-VALVE HI-FI

RADIOGRAM CHASSIS

Incorporating Mullard 5/10 bass boost amplifier, treble boost dual wave tuned R.F. stage Built-in pre-amplifier for microphone or tape recorder including Jensen twin speaker.

£44/15/-

Dual wave, 6 valve radiogram chassis includes bass & treble boost, 12" Jensen or Magnavox speaker.

£23/15/-

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Formers in cans with special V.H.F. tuning slugs and winding data for video and sound I.F.s and traps. 6/6ea.

E.H.T. Transformers for 3000v £1/15/-ea. 5000v Insulation Fil Transformers £2/-/- ea.

Video and sound I.F.s ratio detectors and traps to A.W.A. circuit specifications Prealigned .. .. 19/6 ea.

Wired and tested video and sound I.F. strip with traps and ratio detector including valves and circuit. Including valves £21/-/-

Wired and tested. Strip as above but using new ex-disposal valves and circuit etc. £17/-/-

N.B. All equipment complies with P.M.G. specifications.

Turrets, line transformers, yokes, deflection coils and standard 17" tubes available Also first class technical and alignment service.

Coils and I.F.s etc. Including chassis and sockets and circuit for Steans video and sound strip. £6/10/-

R.T. & H.

TV KIT

NOW AVAILABLE

SEE IT IN OPERATION

T.V. TEST EQUIPMENT

Crystal marker generator $5\frac{1}{2}$ megs. & every $\frac{1}{2}$ meg. to 50 megs.

£22/10/-

R.T. & H. WIDE RANGE C.R.O.

Wired & Tested.

£52/10/-

Also simplified version 6in C.R.O. P.P. Deflection.

£44/15/-

4 SPEED PLAYERS

£11/17/6

4 SPEED CHANGERS

£16/17/6

THE NEW SCIENCE OF TRAFFIC CONTROL

(Continued from Page 19)

fence on the edge of the roadway. Drivers have been known to become so conditioned to this that under certain circumstances will fail to respond to a sudden change in the marking and run off the road or collide with other vehicles.

Another example of conditioned response often met with is where a motorist is travelling a "through" road and notices that cross traffic seems to pull up for him at every intersection, thus giving him a clear run through. He becomes so "conditioned" to this that, when he is suddenly confronted with another motorist at an intersection with the same idea it requires an unusually long time to react and gain control. This often causes collisions at intersections.

STUDY OF SPEED

Traffic Engineers have various methods of studying speeds on roads. Space does not permit of details of the various devices used for this. They range from mirrors, tubes across the road actuating counting devices to radar.

Speed is divided into five classifications.

Spot speed is the instantaneous speed of a vehicle at a specified location. Running speed is the average speed over a given course. Operating speed is the running speed sustained over a given route. Cruising speed is the running speed of the vehicle without impediment. Overall speed is the effective speed over a route between terminals.

Of these, spot speed is the one of greatest importance, as it determines the characteristics of the road user, vehicle, volume of traffic over sections of highways such as bridges, etc.

The study of speed values has revealed some peculiar characteristics of road users.

A driver travels faster the farther he goes on a given trip. For long trips over 100 miles he will travel faster by as much as 30 pc compared to short trips.

FASTER WHEN ALONE

The driver travelling alone travels on an average at a speed 2 to 3 miles an hour faster than when carrying passengers.

Contrary to general thought among males, women travel at about the same speed or even a little slower than males.

Under free moving traffic conditions the type of vehicle influences the spot speed. Buses are fastest, followed by heavy trucks. For each year of age, vehicles decrease speeds about 1.5 miles per hour.

On gravel surfaces, spot speeds are about 10 miles per hour below hard road speeds.

On bridges, the spot speeds are usually lower than on level roads, but this varies according to the type of bridge. Plate girder bridges 24 feet or more wide with two lanes cause little reduction in speed, whereas long high truss bridges 24 feet wide will cause a reduction of spot speed of 7 miles per hour.

The greater the number of intersections passed over a given time or distance, the greater is the reduction in spot speeds. Thus in suburban or city areas spot speeds average 25 to 30 miles per hour, while in country districts it averages 40 to 50 miles per hour.

The traffic engineer studies shapes of roads, angles of curvature, different road surfaces, volumes of traffic, types of vehicles, distribution of traffic, origin and destination, stream characteristics, intersection characteristics, parking characteristics, accident characteristics, driver controls, one-way streets, and so on.

From these studies he is able to design measures for control by regulations, signs and signals which, together with a knowledge of the psychology of the individual, tends to make the best use of existing facilities and better design of new facilities.

400-700 GALS./HOUR PUMP AND MOTOR

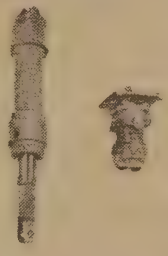
24-32 volt operation. Suit fresh water, fuel, etc.

£14/-/-

P.I. GENERATORS

24 volt, 200 amp. Ideal Welder

NEW £30 Reconditioned £27/10/-



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6000-1, 12-24 volt. As used for control of amateur wireless masts

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for general communication frequencies in the range 3 — 14M.C. — Higher frequencies can be supplied.

IMMEDIATE DELIVERY OF THE FOLLOWING FISHING CRAFT FREQUENCIES

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AMATEUR TYPE CRYSTALS 3.5 AND 7 MC BAND

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£3/-/- each. Plus 12½% Sales Tax. REGRINDS £1/10/-

Crystals for Taxi and Bush Fire Sets also Available.

We would be happy to advise and quote you as to the most suitable for your particular application either in the pressure or vacuum type holder.

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ULTRON 15 series

TAPE HEADS *Extraordinary*

FEATURING:—

★ Extreme Frequency Range.
(20 cps. to 20,000 cps. at 7.5 ins. per sec.)
(20 cps. to 30,000 cps. at 15 ins. per sec.)
★ Triple Magnetic Shielding (—30dB at 50 cps.)
★ High Output.
★ Micro-aligned Gap (record and play with separate heads with no treble loss).

THE ULTRON 15 series are recommended for:—
★ Professional Transcription.
★ All Laboratory Uses.
★ Full Frequency Reproduction of Pre-Recorded Tapes.

By far the most advanced range of tape heads available, the ULTRON 15 series is produced in the following types:—

ULTRON 15, ULTRON 15T, ULTRON 15L . Record-Play, high impedance, .00017in gap
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ULTRON 15S, ULTRON 15ST, ULTRON 15SL . High-Efficiency Record. .003in gap
Note—"T" denotes standard half track; "L" denotes lower half track. All others are full track

SEND 4/- POSTAL NOTE FOR BOOKLET "MAGNETIC TAPE HEADS," containing full specifications of all L.B. Products' tape heads, Hi-Fi Tape Circuits, etc.
A FREE COPY IS SUPPLIED WITH EVERY HEAD.

Retail Prices: ALL ULTRON 15 series £9/13/9
Types HE2, HE2T (record-play, commercial quality) . . £6/ 3/-
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AUTOMATIC PORTABLE TABLEGRAM

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★ Carrying case covered in 2-tone washable nylex with gold trim.

. . . also one of Australia's Best-selling Portables

***Calstan* AUTO-PORTO**

All wanted modern features, 4-speed automatic changer, 5-valve Dual-wave. SENSATIONALLY PRICED.

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FROM THE SERVICEMAN WHO TELLS

(Continued from Page 61)

As the afternoon wore on snippets of conversation wafted over the fence and gave me an inkling of what they were doing:

"Try the red one."

"This one goes to frame."

"Anything on that one?"

"Switch it on now."

And so on.

It didn't need a Sherlock Holmes to deduce that they were working on the car wiring; probably rewiring at least part of it. Apart from registering this fact I didn't take much more notice of the situation until much later in the afternoon.

Then: "Righto Charlie, try it now."

Followed the whine of a starter and the roar of a motor bursting into life. It revved moderately fast for half a minute or so, then cut abruptly, as though someone had switched off the ignition without lifting their foot from the throttle.

"What's the matter?"

"I dunno" (then somewhat dejectedly), "but when I switched the tail light on, the motor cut out."

Well, that's one way to switch off the motor I suppose.

A SIMPLE COURSE IN RADIO

(Continued from Page 47)

rier, without affecting its amplitude. This is then known as FREQUENCY MODULATION.

This latter method has certain advantages in regard to fidelity and freedom from background noise, and is currently used for television sound channels. But, for the present, the beginner can afford to think in terms of the more usual amplitude modulation.

We can thus complete the chapter with a fairly clear idea of a radio transmitter.

First an oscillator generates a high-frequency voltage, which is subsequently greatly amplified to form the carrier.

Then, in the studio, a microphone which converts sound waves into audio frequency signal voltages. These are amplified and ultimately utilised in the transmitter to vary the amplitude (or frequency) of the carrier wave.

Finally the modulated carrier is applied to the aerial and the high frequency signals, carrying the sound pattern in electrical form, are radiated into space.

NEW BOOKS

TELEVISION EXPLAINED, by W. E. Miller. Sixth Edition revised by E. A. W. Spreadbury. Hard cover, 175 8½in x 5½in pages. Photographs and circuit diagrams.

When a book runs to a sixth edition it obviously has some definite appeal. This is not hard to find in the case of "Television Explained" which does just what the title suggests in a simple and straightforward way. It is the type of book that most non-mathematical radiomen could read straight through from cover to cover gaining a good deal of information on the way. A second careful reading and it would be reasonable to claim a good basic knowledge of television principles.

Brief mention is made of the Australian television standards but the emphasis throughout is on the British 405 line system which has a number of fundamental differences to our own. The sound channel for the British system, for example, is of the amplitude modulated variety rather than frequency modulated as in most other systems. Positive video modulation with 405 lines is described while we are employing a negative modulation 625 line system in Australia.

The book could be a real help to the intelligent receiver owner who wishes to know more about general principles rather than to the service technician anxious to gain practical knowledge of our local receivers with a view to tracing faults and carrying out re-alignments.

Our copy of the book direct from the publishers, Iliffe and Sons Ltd., Stamford Street, London. The local price is expected to be in the vicinity of £1/1/ (M.V.F.).

HANDBOOK OF BROADCASTING the Fundamentals of Radio and Television, by Waldo Abbot and Richard L. Rider. Hard cover, 531 pages, 9in x 6in photographs and drawings.

The fourth, and up to date, edition of a book originally published 20 years ago, the "Handbook of Broadcasting" is intended for the student of broadcasting technique from the point of view of program production rather than that of the electronic engineer. Its authors are associated, one with University of Michigan and the other with the University of Illinois.

A total of 29 chapters deal with most aspects of both radio and television production. Among the chapters are "Fundamentals of Radio" and "Fundamentals of Television" being very brief summaries of the external technical facilities the actor needs to understand. The core of the book is made up of chapters such as "Pronunciation," "Music Programs," "Broadcasts to Schools," "Directing the Television Play" and "The Business of Radio and Television."

In keeping with its purpose as a college text, the book concludes with a number of class projects and assignments.

Our copy direct from the McGraw-Hill International Corporation, New York, U.S.A. The American price is eight dollars seventy-five cents (M.V.F.).

LET'S BUY AN ARGUMENT

(Continued from Page 83)

found myself looking for a cure. Silicone compounds were out, because none were available.

What about other greases?

I suddenly remembered a particularly sticky variety, which I had once bought for use with the family car. Packed in a green tin, it rejoiced under the title of "Energol N2, WB and Uni. Joint" grease.

It proved to be just as "gooey" as I had remembered and would not melt and run, on even quite hot regions of the soldering iron.

Intrigued by its tenacity, I began to wonder about its electrical properties, which must certainly have been quite incidental to the original purpose for which it was compounded.

The multimeter showed no measureable conduction while a Q-meter test, next morning, showed no appreciable reaction on the properties of a coil.

A conversation with the manufacturers established that this particular grease did, in fact, have a very high temperature rating and was electrically inert, being compounded with a fibre filler. The same was not true of all special greases, however, some of which are compounded with aluminium, lithium or other metallic substances.

By sheer good fortune, I had picked one of the most suitable of their automotive greases. How it would compare in the long run with silicon is another matter but the cost, at a few shillings a tin, is a very different matter.

By rolling the core in the grease, it would stick well to the sides and carry into the former with it. Put a bit into the former as well, and it would form a sticky pad underneath, further to restrain accidental movement.

Now all this isn't meant as a plug for Energol WB and Uni. Joint grease. There may or may not be other greases which have characteristics more favourable to the job of sticking cores in place, without setting or without melting at normal cabinet temperatures.

It's just an interesting line of thought, particularly for those of our readers who combine an interest in radio with a knowledge of industrial chemistry.

What about it then? Is there a better grease available for the job? Is there some other soap-like substance which might be better again?

BUILDING OUR 17-INCH T.V. RECEIVER

(Continued from Page 79)

leads are kept short and placed logically, no special difficulty should be experienced in duplicating the factory-wired unit. Unless alignment facilities are available, however, such readers will probably need to have the unit aligned by some firm offering this service.

Our impression of the Q-Plus channel is that it can only be aligned satisfactorily with a wobbulator and CRO. We obtained peak results and the curve illustrated earlier by adding slight extra coupling between the "P" and "G" pins on the first double-tuned transformer and also the transformer feeding the video diode.

The extra coupling involved two pieces of thin hook-up wire attached to the respective pins and twisted together for about ½in.

It also helped matters to load the tuned output coil of the tuner and values down to 1,000 ohms can be tried.

The R.C.S. IF components, which are currently just being released, use bifiler transformers in place of the double-tuned overcoupled variety supplied by Q-Plus. According to the manufacturers, R.C.S. compounents may be wired to their own circuit or to the original circuit in the R.T. and H. receiver. They advise the use of two sound stages, however.

The transformers are mounted on a composite video-sound strip which fits the R. T. and H. chassis. The slugs are set in deliberate positions such that, allowing for normal short leads, the stagger-tuned frequencies should approximate those required for a favourable bandpass.

AWA RONETTE

MICROPHONES & ACCESSORIES

Type C53

£4/19/-

Hand or stand mounting. Omnidirectional, black plastic housing and hand grip. Ideal for tape recorders and similar applications

NICHOLSONS LTD.

BARRACK ST., PERTH.

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Six Foolish Drivers	Schlichenmaier	12/-
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NEW MICRO-AMMETERS

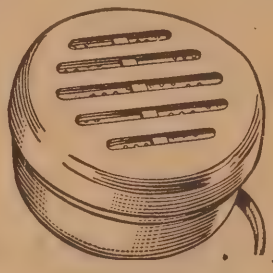
NEW PATON MICRO AMMETERS, 0-500, M.A. 1¾in diameter. Flush mounting.

25/-

Post and Packing 2/6.

METER RECTIFIERS

WESTINGHOUSE 1M.A. METER RECTIFIER. FULL WAVE. NEW. **15/-**



PILLO-FONE

EXTENSION-UNIT

IT'S A REAL MINIATURE WITH ROLA UNIT.

Install it anywhere, in the sick-room, work-shop, garage or any room in the house. Just connect across voice coil of the existing speaker. The "PILLO-FONE" IS THE MOST CONVENIENT LITTLE UNIT YET DEVISED 3¼in Diameter, by 1¾in deep. POST FREE

22/6

("Mercury" American Made.) These relay counters register from 0 to 99,999 can be supplied with 250-ohm coil 24v D.C. operation.

25/-

Plus Postage

NEW AMERICAN BOX KITES

These kites are constructed of Silk with Metal Frame.

SIZE 15in square x 3ft long. Originally used for Aerials for Lifeboat Transmitters.

30/- Post 2/-.

No. 19 TRANSCEIVERS

These units cover a frequency of 2 to 8 mc and contain 15-6.3v valve, including 1-807, 2-6V6S, 6-6K7G, 2-6K8G, 6B8S ETC, 0-1MA-Meter, 4-GANG cond, H.F. Unit ETC.

£6/15/-

F.O.R.

12v Gene Motor for above, **£3/5/-** F.O.R.

VALVE SPECIALS

20/- will purchase any one of the following valve Specials.

2	EL3NG	3	6K8G
3	1P5	5	6SH7
3	1Q5	6	6AC7
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10	1KS	4	KTW62/6U7
5	954	4	12A6
5	EF50	2	6X5GT
3	6SA7	8	EA50
		5	6K7G

Post and Packing 4/6 extra.

ALL VALVES ARE NEW

TRANSMITTING VALVES

829B	£3	5	0
100TH	£2	10	0
866		15	0
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NEW METERS

English Turner 3in Flush Mounting 0-10 mA 15/-

0-600 volt 3in flush with shunt **15/-**

Paton Plug-in type 0-1 amp or 0.350 ma R.F. . . . . **7/6 New**

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0-5, 0-25, 0-250 4in meter mounted in case, used but in good order **£1/2/6**

All Meters—Plus Postage

NEW ROTARY-CONVERTERS

24 to 32 Volt D.C., Input, Output, 240 Volt 50 Cycles at 150 Watts. Suitable for Tape Recorders, Radiograms, Amplifiers, etc.

£16/15/- F.O.R.

No. 122 TRANSCEIVERS

In new condition, complete with valves, vibrator power supply, leads, and dynamic microphone and headphones. These units are easily converted to comply with P.M.G. requirements for small boats, etc. Freq. 2 to 8 meg.

£19/15/-

Packing 20/- extra.

NEW PUSH-BUTTON SWITCHES 20/-

Five pole push-button switches New control box fitted with above switch also 5 bezels with globes and multi contact key switch.

Post: N.S.W. 2/-
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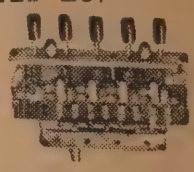

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Used, but in good condition 27/6
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New H.M.V. spring grammo motors less turntable. Adaptable for many uses 19/6
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Small Plate 0-70 PF, Single Hole Mounting, Long-spindle 7/6
Small 7-plate, 0-20 PF 3/6
Small Tubular, 0-20 PF 2/-

SELSYN-MOTORS

American selsyn motors 50 volt transmitter or slave.

£1/17/6. Plus 4/6 Post.

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New motorised hydraulic pumps complete with heavy duty 24 volt motor.

35/- F.O.R.

12V GENEMOTOR

Heavy duty 12v Genemotor—ideal for public address systems etc. Two separate outputs — 270v at 110mA and 550 at 55mA **£4/-/-** F.O.R

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NEW VALVES

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60mA prim.: 240v with 230v tapping, Sec. 285 x 285 with 6.3v filament winding.

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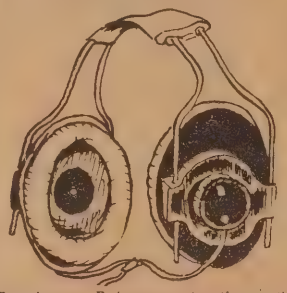

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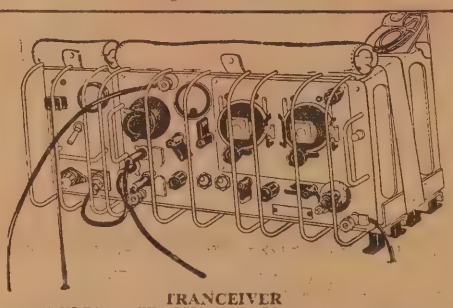

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ANSWERS TO CORRESPONDENTS

A.W.C. (Tarrangindy, Brisbane, Qld.) wishes to know if we are able to supply a copy of the December, 1955, issue, containing an article on the design of a Vacuum Tube Voltmeter.

A. Unfortunately the issue that you require is not available from our back dates department. We suggest that you refer to the classified adds on the last page of this journal, where several readers have, from time to time, advertised back numbers at reasonable cost.

C.M. (Mt. Colah, NSW) writes of a difficulty he encountered in a Control Unit No. 4. According to C.M., it was necessary to insert a .2 meg resistor between the moving arms of the treble switch and a section of the bass switch, which are normally joined together. Failure to do this prevented the treble controls from functioning. C.M. would like to know the reason for this behavior.

A. By including the resistor mentioned, the operation of the treble control would be made very much more severe than intended and would give "alarming" degrees of treble cut. The original intention was to give specific degrees of boost and cut to suit wide-range equipment. The effect may appear to be inadequate if judged on equipment having limited treble response.

R.H.B. (Theodore, Qld.) informs us of a change of address and goes on to express his satisfaction of the performance of the '57 Portable which he has just completed. One point seems to worry our correspondent, namely, a tendency to distortion at maximum volume.

A. Most complaints about distortion at maximum volume in portables arise because it is often overlooked that portables have only limited power output, usually about a quarter of a watt. In a good signal area this may be achieved with the volume control set at about a quarter to half its rotation. Turning the volume up to near maximum or maximum, merely produces overload distortion.

Much the same applies to the '57 Portable which, even on AC, with the 6AQ5 in circuit, is limited to a maximum output of about one watt.

Incidentally, an error occurred in the original circuit of the power supply published in the December, 1956, issue. A correction was subsequently published but, in case you are not aware of the nature of this error, the values on two resistors were interchanged. The resistors are the 330 ohm and the 2000 ohm dropping resistors in the high tension and low tension circuits.

J.D.C. (Salisbury, Qld.) writes to tell us of his success with the transistor set described in the April, 1957, issue. As well as good reception of some of the local stations he is also receiving Radio Australia and some foreign broadcasts.

A. Many thanks for the comments, J.D.C., and we are glad to hear that you are having so much success with the little set. We are planning a more elaborate set at the moment and suggest that you might find it an interesting project also. Your reception of short-wave signals is in line with several other readers who have written us on this matter. Strangely enough, no one seems to have done the logical thing in these circumstances, so far, and wound a coil to cover these ranges, rather than depend on some obscure random effect. We suggest it would be well worth trying.

D.J.Mc. (Ascot Vale, Vic.) inquires about the Bicycle Radio described in the February, 1956, Reader Built It page, being apparently puzzled by the coil connections.

A. Unfortunately you have not stated your problem as completely as is desirable, D.J.Mc., and this makes it hard for us to help you. The coil you purchased should have a data sheet giving the pin connections or you should be able to obtain one from the makers. We imagine the point that may be worrying you is the presence in some types of coils of two aerial connections, these being intended for use with different lengths of aerials. It is merely a matter of using whichever one gives the best results.

A.T. (Villawood, NSW) intends to build the 4-valve set described in the March, 1957, issue, using an electrodynamic speaker and a 385 volts per side power transformer. A.T. would appreciate our advice on any alterations that may be required.

A. The use of an electrodynamic speaker and a 385 per side transformer will not be a major problem with the above set. The existing filter circuit cannot be used and a standard capacitance input filter, with a 5Y3 or similar rectifier, will be required. The value of the first filter capacitor will have to be 8 or 16 mfd and rated at 525 volts at the least. The second filter capacitor will have to have a similar rating but the specified value may be retained. The speaker field coil will be used as a choke between the two filter capacitors. A dropping resistor after the filter, to feed the output valve screens and the preceding stages, will be necessary and the specified value may be retained.

The plates of the output valves should be fed from the second filter capacitor, at which point there should be about 260 volts. Any excess voltage will have to be got rid of. The best method of doing this is to insert a heavy duty resistor between the filament of the rectifier and the input to the filter system. A resistor of a few hundred ohms would be adequate and would limit the peak voltage from the rectifier.

L.G.H. (Box Hill, Vic.) says he likes reading R.T. and, H. and would like to see a discussion of mercury cells in "Answer Tom". He would also like to see the "Course In Television" released as a book.

A. Thanks for your appreciative remarks and for the suggestions. We will pass your request on to the staff member who looks after "Answer Tom". We'll make a decision about the "Course In Television" later, when it is nearing completion.

T.J.S. (Hawthorn, Vic.) says that he connected a 0.1 meg. potentiometer in series with the positive lead from the B-battery to his one-valve set. Turning the pot. to full resistance appeared to bring in another station close to the one he was listening to, and also affected the tone. Why?

A. We tip that turning the control to maximum affected and reduced the amount of regeneration, which would have a secondary effect on both selectivity and tuning. As for the change in tone, this could also be due partly to the change in regeneration. More especially, however, introduction of the resistance would upset the audio return circuit and make the phones sound more peaky. They would deliver highest output at frequencies where their impedance was highest.

R.D. (Meadowbank, NSW) sends in a number of queries for the "Answer Tom" feature and suggests that we describe a crystal set amplifier, preferably using the types 30 or 19 valves.

A. Many thanks for the queries and suggestion, R.D.; we shall include the queries at the earliest opportunity. An amplifier to suit your requirements was described in the June, 1949, issue and reprints of the circuit and text are available through our query service.

W.J.C. (Canberra, ACT) writes to say that he has completed the 17-watt U-L amplifier and Control Unit No. 4, both of which are performing very well. However, he finds that the gain is not sufficient for use with a variable reluctance pickup and would like us to suggest a means of increasing the gain without prejudicing the performance. He would also like our opinion on whether it is advisable to rewire the EF86 in first stage of the amplifier for pentode operation.

A. We feel that the 17-watt U-L amplifier has as much gain as is permissible for this type of circuit, and it would not be possible to increase the gain without inviting trouble with noise after the gain control. Rewiring the EF86 as a pentode or decreasing feedback would alike produce this effect. The lack of gain is due to the control unit, but the simple addition of a pre-amplifier stage would almost certainly cause instability. The most logical solution would be the use of a control unit suitable for the pickup and we advise the Control Unit No. 6.

J. M. (Nathalia, Vic) is interested in the 17in T.V. receiver and suggests that for this and other projects we should indicate the alternative valve types for those specified.

A. Many thanks for your suggestion J.M. and we appreciate your problem. Unfortunately, such a procedure is not as simple as it sounds. The situation you mention is only one combination of possible types. There would be many others, some of which are more readily useful than others, according to the degree of circuit change, socket change, etc. necessary. In the circumstances we can only publish the preferred types and leave it to the experimenter to make his own investigations of alternative types. In most cases, where the valves are on hand, this is not difficult and very little is risked if the idea has to be abandoned. In the case of the types you mention we feel that they would work in most cases, though we have not had the opportunity to try them ourselves and so cannot forecast their behaviour exactly.

S.L.M. (Wingham, N.S.W.) encloses a number of queries for the Answer Tom feature and has some favourable comments to make regarding our journal.

A. The query concerning wattage consumption of receivers has been dealt with in at least two recent issues and we suggest that you look them up. We shall file the rest of the queries for use at the earliest opportunity. We thank you for the appreciative comments and trust that you will continue to enjoy our publication.

L.W.R. (Applecross) is thinking of building a portable radio receiver using transistors but would like to wait for our design, that is if it is not likely to be too long in forthcoming.

A. We are seriously considering the design of a transistorised portable receiver but cannot make any definite promises for the near future for a number of reasons. The most important is that supplies of the necessary high frequency transistors are not in sufficient quantity to cover likely demands at the moment and may not be so for some months. Also suitable coils for the receiver are not as yet obtainable and before they could be released on the general market a period of design and development would have to take place. Finally, the circuit development and final proving is a major project which will require the expenditure of a considerable amount of energy on the part of our staff. Unless you feel very confident of your knowledge of transistor principles etc., we would not recommend that you undertake the design of such a receiver independently.

The Radio, Television and Hobbies Query Service

All queries concerning our designs, to which a POSTAL REPLY is required must be accompanied by a postal note or stamps to the value of TWO SHILLINGS.

For the same fee, we will give advice by mail on radio matters, provided the information can be drawn from general knowledge. UNDER NO CIRCUMSTANCES, however, can we undertake to answer problems involving special research, modification to commercial equipment or the preparation of special circuits.

Whatever the subject matter, we must work on the principle that a letter is too involved if the reply takes more than 10 minutes of our time.

Queries not accompanied by the necessary fee will be answered FREE in the columns of the magazine and presented in such a way as to be of interest to other readers.

To those requiring only circuit reprints, &c., we will supply for TWO SHILLINGS diagrams and parts lists from our files covering up to three constructional projects. Scale blueprints showing the position of all holes and cutouts in standard chassis can be supplied for 5/-. These are available for nearly all our designs but please note they do NOT show wiring details.

Address your letters to The Technical Editor, RADIO, TELEVISION and HOBBIES, Box 2728C, GPO, Sydney.

Note that we do not deal in radio components. Price quotations and details of merchandise must be obtained direct from our advertisers.

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PG68-57

W.G. (Lane Cove, N.S.W.) sends two questions for the "Here's Your Answer Tom" feature.

A. Many thanks for your interest. Your questions have been filed for publication and will be considered as soon as possible.

C.B. (Enfield, N.S.W.) asks about the distances it is possible to send morse code signals.

A. Given suitable conditions, it is possible to send morse code signals anywhere on earth by radio waves. If connecting wires or cables are used it is also possible to send signals around the world although quite involved repeater and amplifier networks required. The simplest way to establish morse communication over distances of the order of one mile is to run a connecting wire between the two points and then use the earth for a return circuit.

A.P.C. (Malvern, Vic.) forwards details of an arrangement for use in conjunction with a clock radio which enables the volume to be set at a low level to assist slumbers in the evening but automatically adjusts itself to a high volume when it switches on in the morning.

A. Thanks for your interest and, as suggested, we will keep your letter for possible future use in the "A Reader Built It" page. The remainder of your remarks were read with interest and we will be particularly happy to pass your appreciative comments on to Mr. Walters.

J.E.B. (Hobart, Tas.) asks about the purpose of a beat frequency oscillator in a receiver and also if we intend to publish another shortwave handbook.

A. Unmodulated morse code signals are heard in an ordinary receiver only as a change in the background noise level and when the signals are very weak may not be audible at all. An oscillator in the receiver can be mixed with the incoming signal at the detector valve when a signal equal to the difference between the two will be heard in the output. By varying the B.F.O. frequency, the note can be varied. We would like to publish another shortwave handbook but pressure of other projects which seem to take an increasing amount of laboratory developmental time as the years go by make it very difficult.

G.G. (East Fremantle, W.A.) asks about the broadcast coil for the Three Band Two receiver described recently. Also he would like to know if the receiver can be operated from batteries.

A. The broadcast coil was intended to be home wound and full details were given on page 53 of the May issue. The coil had a tuned winding tapped for the cathode of the valve and therefore it may not be possible to buy a suitable commercial coil. A 4.5 volt supply would not be suitable for the valve heaters and even with a 6-volt supply, the current drain would be fairly high, making the operation of the set fairly expensive. Results would probably be quite acceptable with a 90 volt high tension supply for headphone operation at least.

R.C. (Mundalla, S.A.) is very interested in the bushfire communications equipment described some years ago, but would like to see the design of a packset suitable for this type of work published. He makes a number of general comments among them that the range we suggest for crystal sets is too low.

A.: We agree that a packset design would be a good thing, but it takes time to design, develop and construct laboratory models of equipment of this sort. In the meantime there are dozens of other projects demanding consideration. Reception of stations 100 miles away with a crystal set is certainly possible, and, judging from reader's comments, must happen fairly often. However, everyone building a crystal set cannot expect such performance, and it is better not to persuade our younger readers to spend their money on a project, which has small chance of success. A maximum range of 15 miles is a fair estimate. Your remaining remarks were read with interest.

J.R.A. (Petersham, N.S.W.), has recently bought a disposals transceiver and would like us to explain some of the markings on the panel.

A.: The receiver function switch would appear to control the automatic volume control and beat frequency oscillator. In the "CW" position we would imagine that the BFO would be switched on and the AVC rendered inoperative or given a very long time constant. Unmodulated morse code signals would be received in this position. With the control switched to "AVC" the BFO would be switched off and the AVC operating normally for the reception of radiotelephony signals i.e., normal speech. In the "R T MAN" position both the AVC and the BFO would be switched off. This position may be useful for the reception of modulated CW signals and also of a relatively weak signal in the presence of interference from a strong station. The transmitter function switch would adjust the transmitter to send unmodulated morse signals in the "CW" position, modulated morse signals in the "MCW" position while the microphone would modulate the transmitter in the "SPEECH" position. The "CRASH LEVEL" control sets the maximum audio output of the receiver and saves the operator from distress in the presence of heavy interference. Finally the "CW H'DYNE" knob determines the frequency of the heterodyne beat note when the receiver is switched to the CW position.

T.F. (Caulfield, Vic.) writes to describe a rather puzzling phenomenon concerning the effect of a crystal set on two adjacent receivers, the volume of these latter being reduced on all stations except the one to which the set was tuned.

A.: This appears to be a simple case of the crystal set functioning as a wave trap. The fact that the other sets were operating on inefficient aerials and were probably so old as not to employ AVC would contribute to the effect. The presence of a large aerial in the immediate vicinity of the other sets would rob them of some energy. This would be least at the frequency to which the set was tuned, since the tuned circuit would present a high impedance at this frequency.

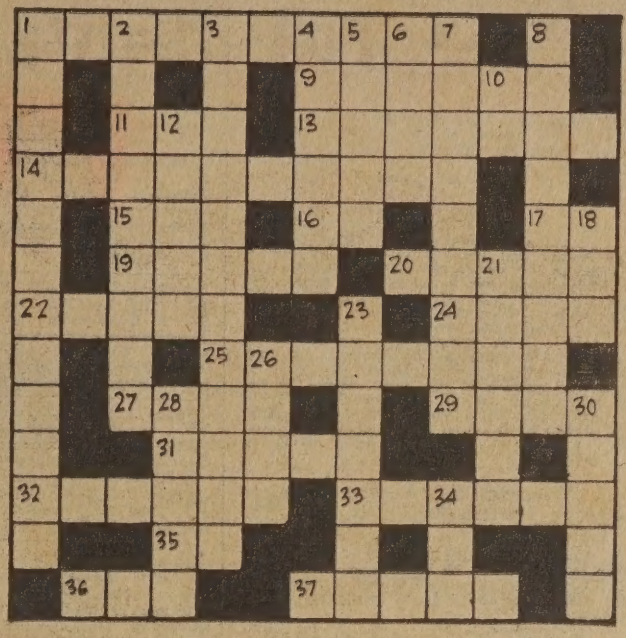
M.J.A. (Vermont, Vic.), forwards a query regarding the purchase of a back issue containing the Playmaster Baby Tuner.

A.: The Playmaster Baby Tuner was described in the May, 1956, issue and we have a number of copies left. These are available, through the query service, for a fee of two shillings.

R.G.B. (c/o H.M.A.S. Cootamundra) asks about back copies of Radio, T.V. and Hobbies and also if we have described amplifiers suitable for operation in conjunction with tape recording equipment.

A. Of the list of back issues you give the only one we are able to supply is that for June 1956. The cost is 2/-, which includes postage. We have published several articles on tape recorders and tape amplifiers. Of these, the articles most likely to be of interest to you appeared in the issue for March, 1953. Unfortunately, the complete description is no longer available but copies of the circuits are available through the normal 2/- query service.

THE R., T.V. & H. CROSSWORD No. 38



ACROSS

1. Valve element (2 words).
9. Non-metallic element used in medicine.
11. Point of a compass.
13. Relieving pain.
14. Unit of elimination.
15. To sit—past tense.
16. Preposition meaning towards.
17. In the matter of.
19. Becomes fatigued.
20. To talk.
22. Musical instrument.
24. To dislike strongly.
25. Blood-sucking insect.
27. Locality of the trouble.
29. To dry out something.
31. Carrier for photographic plates, etc.
32. Elongate plate of dense connecting tissue supporting the eyelid.
33. Dragged or pulled with effort.
35. Prefix meaning no longer.
36. To blend.
37. Resistance paralleled across meter terminals.

DOWN

1. Capacitance effect between parts of the same component (2 words).
2. Variable resistors.
3. TV tube functioning photo-electrically.
4. Being of super-human size.
5. Musical composition.
6. Image made as an object of worship.
7. The marsupial.
8. Converter of mechanical energy into electrical.
10. New York (abbrev.).
12. To dye.
18. To add.
21. Consuming.
23. Cuts off receiver output when no signal is forthcoming.
26. Early American engraver who produced the first lithograph.
28. County in England.
30. The margins, edges or borders.
34. A pistol, rifle.

Solution and further crossword next month

Last Month's Solution

L	I	V	E	T	E	L	E	C	A	S	T	S		
O		I	R	E		I	R	A	T	E		E		
W	H	E	A	T	S	T	O	N	E			R		
F		W		H	E	M	S			T	R	I		
R	H	I	N	E		U		S	H	E		E		
E		N	O	R		S	E	C	O	H	M	S		
Q		G	A	S				L	O	N	E			
U			H		M			E	N	E	R	G	Y	
E	L	A	S	T	A	N	C	E		A				
N			A		I		T		U	N	I	T		
C	U	R	R	E	N	T			S		O			
Y		S	K	Y	E		S		S		T			
		L		E			A	E	R	I	A	L		

Printed and published by Sungravure Ltd., at the registered office: 21-29 Morley Avenue, Rosebery, N.S.W.

G.S. (Ashburton, Vic.) has some questions about valves in television receivers.

A. Valves in a television receiver, including the picture tube, can be expected to have a life comparable with those in a normal sound receiver and may easily last for many years before replacement is necessary. The number of stages in which even the best transistors available at this time can be used is limited and it would probably be more trouble installing a special power supply for them than would be warranted. The power saved due to the high efficiency of the transistor would be only a small fraction of the total power required by the receiver.

J.S. (Bairnsdale, Vic.) complains of a humming noise in his version of the "Three-Band-Two" receiver which was described in the May, 1957, issue. The level of the hum is affected by the setting of the volume control.

A. Most likely cause of the noise is pickup of electric hum fields by the control grid of the 6U8 pentode section (pin 2). Both the 0.68 meg. resistor and the 100 pF capacitor should be close to the socket and, in the normal way, the leads should not be more than about ½in from the main body of the component to the valve socket. Filament and other leads from the power transformer shoruld be kept away from this point. With exceptionally sensitive headphones, the hum due to the ripple in the high tension line may be objectionable. It could be reduced by placing a .047 meg. resistor in the line between the 16 uF filter capacitor and the junction of the two .1 meg. resistors. This latter point should be bypassed by an electrolytic capacitor. A suitable value would be 8 uF or 16 uF.

C.A. (Launceston, Tas.) would like to obtain back issues containing the "A Course in Television" series.

A. Unfortunately, the complete course is no longer available but we can forward the May, 1956, issue containing Part 9 and all issues to date. The usual charge is 2/- per copy, postage included.

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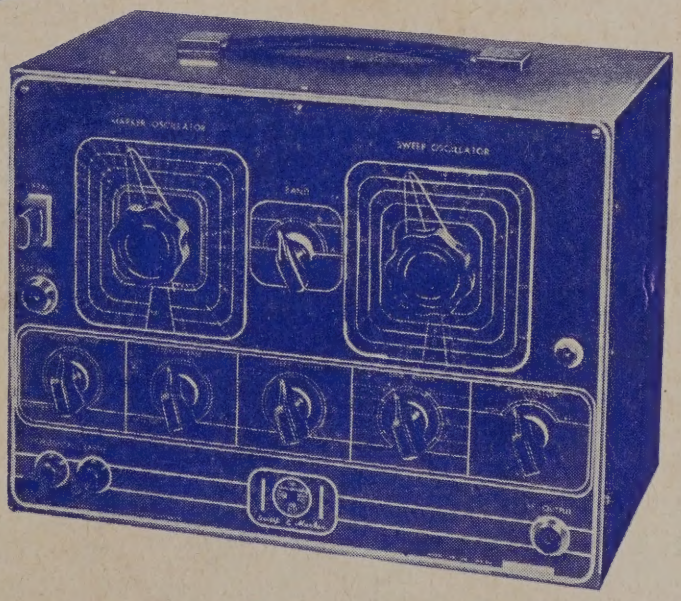

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